D
DEC 1 1982
ALEXANDER L. STEVAS,

No. 81-2399, No. 82-358

IN THE

Supreme Court of the United States

OCTOBER TERM, 1982

METROPOLITAN EDISON COMPANY, JERSEY CENTRAL POWER & LIGHT COMPANY, and PENNSYLVANIA ELECTRIC COMPANY, *Petitioners*,

v.

PEOPLE AGAINST NUCLEAR ENERGY, *et al.*, *Respondents*.

UNITED STATES NUCLEAR REGULATORY COMMISSION and THE UNITED STATES OF AMERICA, *Petitioners*,

v.

PEOPLE AGAINST NUCLEAR ENERGY, *et al.*, *Respondents*.

On Writs Of Certiorari To The United States Court Of Appeals For The District Of Columbia Circuit

JOINT APPENDIX

REX E. LEE
Solicitor General
United States Department of Justice
Washington, D.C. 20530
(202) 633-2217

LEONARD BICKWIT, JR.
General Counsel
Nuclear Regulatory Commission
Washington, D.C. 20555
(202) 634-3288
Counsel for Petitioners Nuclear Regulatory Commission and United States of America

JAMES B. HAMLIN
SHAW, PITTMAN, POTTS & TROWBRIDGE
1800 M Street, N.W.
Washington, D.C. 20036
(202) 822-1000
Counsel for Petitioners Metropolitan Edison Company, et al.

WILLIAM S. JORDAN, III
HARMON & WEISS
1725 I Street, N.W.
Suite 506
Washington, D.C. 20006
(202) 833-9070
Counsel for Respondent People Against Nuclear Energy

PETITIONS FOR CERTIORARI FILED JULY 1, 1982 AND AUGUST 30, 1982
CERTIORARI GRANTED NOVEMBER 1, 1982

TABLE OF CONTENTS

	Page
Relevant Docket Entries	1
Order of the U.S. Nuclear Regulatory Commission, dated July 2, 1979, 44 Fed. Reg. 40,461 (1979)	8
Order and Notice of Hearing of the U.S. Nuclear Regulatory Commission, dated August 9, 1979, CLI-79-8, 10 N.R.C. 141 (1979)	9
People Against Nuclear Energy, Preliminary Plan for Presentation of Evidence on Psychological Distress, dated November 2, 1979	26
Certification to the Commission on Psychological Distress Issues by the Atomic Safety and Licensing Board, dated February 22, 1980, LBP-80-8, 11 N.R.C. 297 (1980)	29
Environmental Impact Appraisal by the NRC Division of Engineering Evaluating the Proposed Restart of Three Mile Island, Unit 1, dated March 27, 1981	48
Supplement to Environmental Impact Appraisal by the NRC Division of Engineering Evaluating the Proposed Restart of Three Mile Island, Unit 1, dated May 11, 1981	66
Report of the President's Commission on the Accident at Three Mile Island—The Need for Change: The Legacy of TMI, pp. 12-19, 34-35, 118, 126-130 (October 1979)	88

The following opinions, decisions, judgments and orders have been omitted in printing this Joint Appendix because they appear on the following pages in the appendix to the printed Petition for Certiorari in No. 81-2399:

People Against Nuclear Energy, Draft Contentions Relating to Psychological Distress, filed October 5, 1979	115a
Memorandum and Order of the U.S. Nuclear Regulatory Commission on Psychological Distress, dated December 5, 1980, CLI-80-39, 12 N.R.C. 607 (1980)	77a
Order of the U.S. Nuclear Regulatory Commission on Psychological Distress, dated September 17, 1981, CLI-81-20, 14 N.R.C. 593 (1981)	101a

Judgment of the Court of Appeals, issued January 7, 1982 ..... 105a

Amended Judgment of the Court of Appeals, issued April 2, 1982 ..... 103a

Opinions of the Court of Appeals and Amended Judgment, issued May 14, 1982 ..... 1a

RELEVANT DOCKET ENTRIES

UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT

No. 81-1131

PEOPLE AGAINST NUCLEAR ENERGY, *Petitioner*,

v.

UNITED STATES NUCLEAR REGULATORY COMMISSION and THE UNITED STATES OF AMERICA, *Respondents*,

METROPOLITAN EDISON COMPANY, *et al.*, *Intervenors*.

DATE	FILINGS — PROCEEDINGS
02-03-81	4-Petitioner's petition for review of an order of the NRC
02-06-81	4-Motion of Metropolitan Edison Company, et al. for leave to intervene
02-12-81	4-NRC's motion to dismiss petition for review
02-23-81	4-Petitioner's opposition to NRC's motion to dismiss
03-05-81	Clerk's order granting the motion of Metropolitan Edison Company, et al. (Public Utilities) for leave to intervene
03-05-81	4-Intervenors' motion to expedite consideration of NRC's motion to dismiss and petitioner's petition for review
03-05-81	4-Intervenors' memorandum in opposition to motion to dismiss and in support of motion to expedite
03-05-81	4-Petitioner's opposition to intervenors' motion to expedite

DATE	FILINGS — PROCEEDINGS
03-05-81	4-Intervenors' reply in support of their motion to expedite
04-14-81	Per Curiam order that respondent's motion to dismiss is denied; and that the motion to expedite consideration of the petition for review is denied; and that the time for filing the certified index to the record herein is extended 10 days from the date of this order; CJ McGowan, Tamm and Wald (who did not participate), CJ's
04-24-81	Certified Index to Record
08-24-81	7-Joint appendix
09-02-81	4-Petitioner's motion for expedited argument and decision
09-02-81	15-Petitioner's brief
09-02-81	15-Petitioner's reply brief
09-04-81	15-Respondent's brief
09-08-81	15-Intervenors' brief
09-09-81	4-NRC's response to petitioner's motion for expedited argument and decision
09-09-81	4-Intervenors' memorandum in opposition to Petitioner's motion for expedited argument and decision
09-22-81	Per Curiam order that petitioner's motion for expedited argument and decision is denied. The Court notes that oral argument in this case has already been scheduled for November 17, 1981, and that the respondent Commission has represented to this Court that the Commission is unlikely to authorize restart of Three Mile Island Unit 1 before December, 1981. Any subsequent

DATE	FILINGS — PROCEEDINGS
	motions in this case will be directed to the merits panel already assigned to this case; Wright, Mikva (who did not participate) and Ginsburg, CJ's
10-06-81	4-Letter from NRC stating that it adheres to its original decision
11-10-81	Clerk's order, sua sponte, that the following times are allotted for the oral argument of this case: Petitioner - 20 minutes; Respondents - 20 minutes
11-10-81	15-Intervenors' supplemental brief
11-17-81	Argued before Wright, Wilkey*, CJ's; and McGowan, SCJ. Commission to file supplemental memorandum
11-25-81	4-Respondents' memorandum on the status of the Three Mile Island Unit 1 restart proceeding
12-01-81	4-Intervenors' response to NRC's report on status of TMI-1 restart proceeding
12-02-81	Per Curiam order, sua sponte, that on or before Monday, December 7, 1981 the Nuclear Regulatory Commission file with the Clerk of the Court answers to the following questions: Have any parties other than those in Appeal No. 81-1131 initiated any proceedings of any kind seeking to compel the Commission to issue an environmental impact statement (EIS) or a supplemental EIS with respect to the restart of Three Mile Island Nuclear Station Unit No. 1? If so, provide the court with a status report thereon. What is the date of the Commission's negative declaration indicating that no EIS or supplemental EIS would be prepared before the start of Three Mile Island Unit No. 1? Have any parties sought review of this

DATE	FILINGS — PROCEEDINGS
	action by the Commission? If so, provide the court with a status report thereon; Wright, CJ; McGowan, SCJ; and Wilkey, CJ
12-07-81	4-NRC's response to the Court's order of 12/02/81
12-18-81	4-NRC's motion for leave to file documents with the Court
01-05-82	Per Curiam order that NRC's motion for leave to file documents is granted; Wright, CJ; McGowan, SCJ; and Wilkey, CJ
01-05-82	4-NRC's documents (Memorandum and order on NEPA - Compliance issues) - filed per above order
01-05-82	4-NRC's document (Blue Book - Partial Initial Decision) - filed per above order
01-07-82	Judgment that the order of the NRC under review is vacated. Further ordered that the NRC shall prepare an environmental assessment regarding the effects of the proposed restart of the nuclear facility at Three Mile Island Unit One on the psychological health of neighboring residents and on the well-being of the surrounding communities. Until the NRC has complied with the requirements of the NEPA as described in the preceeding paragraph, it shall not make a decision to restart TMI-1. The NRC shall prepare a statement of the reasons for its determination that psychological health is not cognizable under the Atomic Energy Act. Judge Wilkey dissents (see judgment for details). Opinions to follow
01-07-82	Order on issuance of mandate
01-11-82	4-Respondents' motion to extend time to file rehearing of this Court's judgment of 01/07/82

DATE	FILINGS — PROCEEDINGS
01-11-82	4-Intervenors' motion to extend time to file petition for rehearing
01-15-82	Per Curiam order that respondents' motion of extension of time is granted and the time within which to file petitions for rehearing and/or suggestions for rehearing en banc shall commence on the day following the issuance of the opinion(s) of the Court; Wright, CJ; McGowan, SCJ; and Wilkey, CJ
01-18-82	4-Petitioner's consent to motions for extension of time
03-30-82	4-NRC's response to the Court's order of 01/07/82
04-02-82	Amended judgment that this case is remanded to the NRC for a determination of whether significant new circumstances or information have arisen with respect to the potential psychological health effects of operating the TMI-1 facility. Also adjudged that the injunction granted on 1-7-82 is vacated. Opinions to follow
04-07-82	4-Petitioner's motion to permit supplemental briefing
04-15-82	Per Curiam order that any written comments which either petitioner, respondents, or intervenors may wish to make with respect to the Commission's memorandum and order, dated March 30, 1982, are to be filed within 10 days from the issuance of this order; Wright and Wilkey, CJs and SCJ McGowan
04-15-82	4-Intervenors' opposition to petitioner's motion to permit supplemental briefing
04-16-82	4-Respondent's (NRC) response to motion to permit supplemental briefing

DATE	FILINGS — PROCEEDINGS
04-20-82	4-Transcripts of oral argument
04-23-82	4-Intervenors' (Metropolitan Edison Co., et al.) comments on NRC's memorandum and order concerning the Atomic Energy Act
04-26-82	4-Petitioner's comments on NRC's memorandum and order of 3/30/82
05-14-82	Opinions for the Court filed by CJs Wright and Wilkey (AEA issue)
05-14-82	Dissenting opinion filed by CJ Wilkey
05-14-82	Dissenting opinion filed by CJ Wright (AEA issue)
06-02-82	4-Intervenors' (Metropolitan Edison Co., et al.) motion to extend time to file petition for rehearing and suggestion for rehearing en banc to 6/28/82
06-08-82	Clerk's order that the motion of the Public Utilities for extension of time is granted and the time within which to file petitions for rehearing and/or suggestions for rehearing en banc is established as 06/28/82
06-24-82	Copy of letter from Clerk, SC extending time to file petition for writ of certiorari in SC No. A-1106 to August 20, 1982 (Letter dated 6/23/82)
07-07-82	Notice from Clerk, Supreme Court that petition for writ of certiorari was filed on 07-01-82 in SC No. 81-2399
08-17-82	Copy of letter from Clerk, SC extending time to file petition for writ of certiorari to 8/30/82 in SC No. A-1106 on August 12, 1982

DATE	FILINGS — PROCEEDINGS
09-01-82	Notice from Clerk, Supreme Court that petition for writ of certiorari was filed on 08-30-82 in SC No. 82-358 (United States Nuclear Regulatory Commission)
11-02-82	Certified copy of order from Clerk, Supreme Court that petition for writ of certiorari was granted on 11-01-82 in 81-2399

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

[Docket No. 50-289]

Metropolitan Edison Co. (Three Mile Island Nuclear Station, Unit No. 1); Order

In view of the variety of issues raised by the accident at the Three Mile Island Unit No. 2 facility, the Commission presently lacks the requisite reasonable assurance that the same licensee's Three Mile Island Unit No. 1 facility, a nuclear power reactor of similar design, can be operated without endangering the health and safety of the public. Accordingly, we direct that the Unit No. 1 facility, presently in a shutdown condition, shall remain shut down until further order of the Commission itself. The Commission has further determined that it is in the public interest that a hearing precede restart of the facility. The Commission will also issue an order within thirty (30) days specifying in detail the basis for its concerns, and the procedures to govern further proceedings in this matter. The licensee may file a written answer to this Order no later than twenty (20) days after the issuance of the detailed Order.

The Commission has found that the public health, safety and interest require that this order be effective immediately.

It is so ordered.

Dated at Washington, D.C. this 2nd day of July 1979.

For the Commission.

John C. Hoyle,
Acting Secretary of the Commission.

10 NRC 141 (1979)

CLI 79-8

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

COMMISSIONERS:
Joseph M. Hendrie, Chairman
Victor Gilinsky
Richard T. Kennedy
Peter A. Bradford
John F. Ahearne

In the Matter of

METROPOLITAN EDISON COMPANY — Docket No. 50-289

(Three Mile Island Nuclear Station, Unit No. 1) — August 9, 1979

ORDER AND NOTICE OF HEARING

In an immediately effective order the Commission orders Three Mile Island, Unit No. 1 to remain in a cold shutdown condition until the issuance of a further order by the Commission following (1) satisfactory completion by the licensee of certain "short-term" actions and (2) reasonable progress by the licensee toward satisfactory completion of certain "long-term" actions. The Commission orders a hearing; and establishes a licensing board to rule on petitions to intervene, conduct the hearing, render an initial decision and, upon issuance of a partial initial decision or initial decision, to certify the record to the Commission itself for final decision. The Commission sets out guidelines on the conduct of the hearing including the raising of issues relating to the licensee's financial qualifications and specifying interlocutory consideration of issues such as the psychological distress and others arising from the continuing impact of aspects of the Three Mile Island accident unrelated directly to exposure to radiation on the part of citizens living near the plant. The Commission establishes a procedure to be applied in the event the Licensing Board issues

a decision authorizing resumption of plant operation for determining whether the provision of the instant order requiring the plant to remain shutdown should remain immediately effective pending appellate review of the merits of the Board's decision by the Commission.

I.

The Metropolitan Edison Company (the licensee) is holder of Facility Operating License No. DPR-50 which authorizes the operation of the nuclear power reactor known as Three Mile Island Nuclear Station, Unit No. 1 (the facility or TMI-1), at steady state power levels not in excess of 2535 megawatts thermal (rated power). The facility is a Babcock and Wilcox (B&W) designed pressurized water reactor (PWR) located at the licensee's site ten miles southeast of Harrisburg, Pennsylvania.

II.

On July 2, 1979, the Commission ordered that the facility remain in a cold shutdown condition until further order of the Commission and stated that a hearing will be conducted prior to any restart of the facility. On the basis of that hearing the Commission will determine whether any further operation will be permitted and, if so, under what conditions. The Commission herein specifies the basis for its concerns and the procedures to govern further proceedings in this matter. For the reasons later set forth, the Commission has determined that satisfactory completion of certain short-term actions and resolution of various concerns described herein are required to provide reasonable assurance that the facility can be operated without endangering the health and safety of the public. The Commission has determined that certain additional long-term actions are, for the reasons given below, required to be completed as promptly as practicable, and that reasonable progress on the completion of such actions prior to restart is required, in order to provide reasonable assurance that the facility can be operated safely over the long term. This Order and Notice of Hearing further establishes procedures for a hearing

and decision on the particular issues identified in Section V of this Order. The Commission has determined that hearing and decision with review thereof (as provided in Sections V and VI below) on the issues specified in this order is required and that such hearing, decision and review on the issues relating to the actions required prior to restart of the facility must be completed prior to any Commission Order lifting the suspension of operation.

Accordingly, the Atomic Safety and Licensing Board designated to conduct this proceeding should give priority to consideration of those issues which are related directly to suspension of operation. To the extent feasible, the Board should defer full review of the issues related to the longer-term actions until after the rendering of a partial initial decision regarding the suspension-related issues.

The Commission's July 2, 1979 Order recited that "the Commission presently lacks the requisite reasonable assurance that the . . . Licensee's Three Mile Island Unit No. 1 Facility . . . can be operated without endangering the health and safety of the public." The bases for that conclusion (which remains valid) are: In the course of its evaluation to date of the accident at the Three Mile Island Unit No. 2 facility, which utilizes a B&W designed PWR, the Nuclear Regulatory Commission staff has ascertained that B&W designed reactors appear to be unusually sensitive to certain off-normal transient conditions originating in the secondary system. The features of the B&W design that contribute to this sensitivity are: (1) design of the steam generators to operate with relatively small liquid volume in the secondary side; (2) the lack of direct initiation of reactor trip upon the occurrence of off-normal conditions in the feedwater system; (3) reliance on an integrated control system (ICS) to automatically regulate feedwater flow; (4) actuation before reactor trip of a pilot-operated relief valve on the primary system pressurizer (which, if the valve sticks open, can aggravate the event); and (5) a low steam generator elevation (relative to the reactor vessel) which provides a smaller driving head for natural circulation.

Because of these features, B&W designed reactors place more reliance on the reliability and performance characteristics of the auxiliary feedwater system, the integrated control system, and the emergency core cooling system (ECCS) performance to recover from frequent anticipated transients, such as loss of offsite power and loss of normal feedwater, than do other PWR designs. This, in turn, places a large burden on the plant operators in the event of off-normal system behavior during such anticipated transients.

As a result of a preliminary review of the Three Mile Island Unit No. 2 accident chronology, the NRC staff initially identified several human errors that occurred during the accident and contributed significantly to its severity. All holders of operating licenses, except Metropolitan Edison, whose plants were already shut-down, were subsequently instructed to take a number of immediate actions to avoid repetition of errors, in accordance with bulletins issued by the Commission's Office of Inspection and Enforcement (IE). In addition, the NRC staff began an immediate reevaluation of the design features of B&W reactors to determine whether additional safety corrections or improvements were necessary with respect to these reactors. This evaluation involved numerous meetings with B&W and certain of the affected licensees.

The evaluation identified design features as discussed above which indicated that B&W designed reactors are unusually sensitive to certain off-normal transient conditions originating in the secondary system. As a result, an additional bulletin was issued by IE which instructed holders of operating licenses for B&W designed reactors to take further actions, including immediate changes to decrease the reactor high pressure trip point and increase the pressurizer pilot-operated relief valve setting. Also, as a result of this evaluation, the NRC staff identified certain other safety concerns that warranted additional short-term design and procedural changes at operating facilities having B&W designed reactors. These were identified as items (a) through (e) on page 1-7 of the Office of Nuclear Reactor Regulation Status Report to the Commission of April 25, 1979.

In addition to the items identified for the other B&W reactors, the unique circumstances at TMI require that additional safety concerns identified by the NRC staff be resolved prior to restart. These concerns result from (1) potential interaction between Unit 1 and the damaged Unit 2, (2) questions about the management capabilities and technical resources of Metropolitan Edison, including the impact of the Unit 2 accident on these, (3) the potential effect of operations necessary to decontaminate the Unit 2 facility on Unit 1, and (4) recognized deficiencies in emergency plans and station operating procedures. Based on the above, the Commission's Director of Nuclear Reactor Regulation (NRR) has recommended that the following actions (the "short-term actions") be required of the licensee to resolve the concerns stated herein and permit a finding of reasonable assurance that the facility can safely resume operation.

1. The licensee shall take the following actions with respect to TMI-1:

   (a) Upgrade the timeliness and reliability of the Emergency Feedwater (EFW) system by performing the items specified in Enclosure 1 of the licensee's June 28, 1979 letter. Changes in design will be submitted to the NRC staff for review.

   (b) Develop and implement operating procedures for initiating and controlling EFW independent of Integrated Control System (ICS) control.

   (c) Install a hard-wired control grade reactor trip on less [loss] of main feedwater and/or turbine trip.

   (d) Complete analyses for potential small breaks and develop and implement operating instructions to define operator action.

   (e) Augment the retraining of all Reactor Operators and Senior Reactor Operators assigned to the control room including training in the areas of natural circulation and small break loss of coolant accidents

including revised procedures and the TMI-2 accident. All operators will also receive training at the B&W simulator on the TMI-2 accident and the licensee will conduct a 100 percent reexamination of all operators in these areas. NRC will administer complete examinations to all licensed personnel in accordance with 10 CFR 55.20-23.

2. The licensee shall provide for NRC review and approval of all applicable actions specified in IE Bulletins 79-05A, 79-05B, and 79-05C.

3. The licensee shall improve his emergency preparedness in accordance with the following:

   (a) Upgrade emergency plans to satisfy Regulatory Guide 1.101 with special attention to action level criteria based on plant parameters.

   (b)* Establish an Emergency Operations Center for Federal, State, and Local Officials and designate a location and an alternate location and provide communications to plant.

   (c) Upgrade offsite monitoring capability, including additional thermo-luminescent dosimeters or equivalent.

   (d) Assess the relationship of State/Local plans to the licensee plans so as to assure the capability to take emergency actions.

   (e) Conduct a test exercise of its emergency plan.

4. The licensee shall demonstrate that decontamination and/or restoration operations at TMI-2 will not affect safe operations at TMI-1. The licensee shall provide separation and/or isolation of TMI 1/2 radioactive liquid transfer lines, fuel handling areas, ventilation systems, and sampling lines. Effluent monitoring instruments shall have the capability of discriminating between effluents resulting from Unit 1 or Unit 2 operations.

5. The licensee shall demonstrate that the waste management capability, including storage and processing, for solid, liquid, and gaseous wastes is adequate to assure safe operation of TMI-1, and that TMI-1 waste handling capability is not relied on by operations at TMI-2.

6. The licensee shall demonstrate his managerial capability and resources to operate Unit 1 while maintaining Unit 2 in a safe configuration and carrying out planned decontamination and/or restoration activities. Issues to be addressed include the adequacy of groups providing safety review and operational advice, the management and technical capability and training of operations staff, the adequacy of the operational Quality Assurance program and the facility procedures, and the capability of important support organizations such as Health Physics and Plant Maintenance.

7. The licensee shall demonstrate his financial qualifications to the extent relevant to his ability to operate TMI-1 safely.

8. The licensee shall comply with the Category A recommendations as specified in Table B-1 of NUREG-0578.

The Commission has additional concerns, which, though they need not be resolved prior to resumption of operation at Three Mile Island Unit 1, must be satisfactorily addressed in a timely manner. The Commission's Director of Nuclear Reactor Regulation (NRR) has recommended that the following actions (the "long-term actions") be required of the licensee to resolve these concerns and permit a finding of reasonable assurance of the safety of long-term operation. These are:

1. submit a failure mode and effects analysis of the ICS to the NRC staff as soon as practicable;

2. give continued attention to transient analysis and procedures for management of small breaks by a formal program set up to assure timely action of these matters;

3. comply with the Category B recommendations as specified in Table B-1 of NUREG-0578; and,

4. improve emergency preparedness in accordance with the following:

   (a) modify emergency plans to address changing capabilities of plant instrumentation.

   (b) extend the capability to take appropriate emergency actions for the population around the site to a distance of ten miles.

III.

Accordingly, pursuant to the Atomic Energy Act of 1954, as amended, and the Commission's rules and regulations in 10 CFR, it is hereby ordered that:

(1) the licensee shall maintain TMI-1 in a cold shutdown condition until further order of the Commission which will be issued following satisfactory completion of the required short-term actions and reasonable progress toward satisfactory completion of those required long-term actions referred to in section IV (such short-term and long-term actions to be considered "required" for purposes of this clause which are determined by the Commission, after review of the Licensing Board's decision, to be necessary and sufficient to provide adequate protection of the public health and safety); and

(2) the licensee shall satisfactorily complete the long-term actions listed in Table B-1 of NUREG-0578 on the schedule set out in such table and such other long-term actions listed above as promptly as practicable.

IV.

The Commission has determined that, in light of the concerns listed above, the public health, safety, and interest require that the portion of the order referred to in clause (1) of Section III shall be immediately effective. The long-term actions referred to in such clause shall be those long-term actions

listed in Section II as to which the Commission, prior to the date of this order, has issued immediately effective orders against other licensees. If the Commission issues immediately effective orders against other licensees imposing requirements with respect to other long-term actions, it will, to the extent appropriate in the circumstances, issue orders, effective immediately, to require that the licensee demonstrate reasonable progress toward completion of such other actions as a condition to restart. If the Board determines that operation can be resumed upon completion of certain specific short-term actions by the licensee, it shall consider the extent to which the licensee has demonstrated reasonable progress toward completion of the long-term actions described in this section. If it finds that the licensee has demonstrated reasonable progress, it shall recommend resumption of operation upon completion of the short-term actions. If it cannot make such a finding, it shall recommend that operation be resumed at a date that it believes appropriately reflects the importance of the action involved, the time lost because such progress had not been made on the prescribed schedule and the overriding need to provide adequate protection for the public health and safety.

V.

An Atomic Safety and Licensing Board consisting of Ivan W. Smith, Esq., Chairman, Dr. Walter H. Jordan, Member, and Dr. Linda W. Little, Member, is hereby established to rule on petitions to intervene, to conduct the hearing ordered herein, and to render an initial decision in accordance with 10 CFR 2.760. The Atomic Safety and Licensing Board will issue a further order specifying the date and place of the hearing and any prehearing conferences. The Board should hold its sessions in the vicinity of the facility and it should attempt to schedule some of its sessions in the evening or on weekends to permit the maximum possible public attendance.

The hearing will be conducted in accordance with the applicable provisions of subpart G of the Commission's Rules of Practice set forth in 10 CFR Part 2. The provisions of 10 CFR

2.715a (consolidation of parties), 2.751a (special prehearing conference and order), 2.752 (prehearing conference and order) shall apply to this proceeding.

The Commission's primary commitment is to a fair and thorough hearing and decision. Given this overriding imperative, it is the Commission's expectation that the Board will conduct the proceeding expeditiously. The Board should as early as possible publish an appropriate schedule and attempt to meet it. A tentative schedule composed by the Commission is attached for the Board's possible use, although the Board should not be constrained by it. The Board is instructed to explore opportunities to shorten the time limits provided in the Rules pursuant to 10 CFR 2.711. The Licensing Board is hereby instructed to consolidate participation of parties pursuant to 10 CFR 2.715a to the maximum extent practicable consistent with the provisions of that regulation. In its review of the Initial Decision, the Commission will invoke 10 CFR 2.711 to shorten time limits where feasible. It is hereby directed, pursuant to 2.760(a), that, upon issuance of the initial decision (or partial initial decision) in this matter, the record be certified to the Commission itself for final decision. Any party may take an appeal directly with the Commission by filing exceptions to the initial decision (or partial initial decision) in accordance with the provisions of 10 CFR 2.762. Commission review of the initial decision will be conducted in accordance with 10 CFR 2.770.

In the conduct of this proceeding the Licensing Board should exercise its authority to seek to ensure that it receives all information necessary to a thorough investigation and resolution of the questions before it. However, it should use its authority under 10 CFR 2.757 to prevent any undue delay to the proceeding resulting from any cross-examination not required for the full and true disclosure of the facts or from other sources mentioned in that section.

The provisions for pre-hearing discovery set forth in 10 CFR 2.740-2.742 shall apply to this proceeding. Furthermore, in

several locations, including the Commission's Public Document Room and the TMI Local Document Room in Harrisburg, the Commission will maintain and continuously update a compilation of all publicly available information on the Three Mile Island accident and related matters, and it will also permit informal access to NRC staff considerations of the issues involved in this hearing in the manner in which such access is permitted in reactor licensing proceedings. It shall be an adequate response to any discovery request to state that the information or document requested is available in the public compilation and to provide sufficient information to locate the document or information. Moreover, as provided by 10 CFR 2.740(c) and 10 CFR 2.740(d), the Licensing Board may and should, when not inconsistent with fairness to all parties, limit the extent or control the sequence of discovery to prevent undue delay or imposition of an undue burden on any party.

The subjects to be considered at the hearing shall include:

(1) Whether the "short term actions" recommended by the Director of Nuclear Reactor Regulation (set forth in Section II of this Order) are necessary and sufficient to provide reasonable assurance that the Three Mile Island Unit 1 facility can be operated without endangering the health and safety of the public, and should be required before resumption of operation should be permitted.

(2) Whether the "long-term actions" recommended by the Director of Nuclear Reactor Regulation (set forth in Section II of this Order) are necessary and sufficient to provide reasonable assurance that the facility can be operated for the long term without endangering the health and safety of the public, and should be required of the licensee as soon as practicable.

As to the issue of financial qualifications mentioned above, a party wishing to raise this subject as a contention must clearly indicate why the licensee's financial condition might undermine the licensee's ability to operate the plant safely. Parties

raising this issue should do so before the Special Prehearing Conference.

While real and substantial concern attaches to issues such as psychological distress and others arising from the continuing impact of aspects of the Three Mile Island accident unrelated directly to exposure to radiation on the part of citizens living near the plant, the Commission has not determined whether such issues can legally be relevant to this proceeding. Any party wishing to raise such subjects as contentions, or as aspects of separate contentions, should brief the Atomic Energy Act and National Environmental Policy Act issues he believes appropriate to the Board as part of the contention acceptance process set out in the Commission's regulations. The Board should then certify such issues to the Commission for final decision prior to the issuance of its prehearing conference order pursuant to 10 CFR 2.752(c), either with or without its recommendation on such issues, as it deems appropriate under the circumstances. At the time the Commission reaches a decision on these issues, it will also consider whether it can and should grant financial assistance to parties seeking to raise these issues in this case.

Satisfactory completion of the required actions will be determined by the Director of Nuclear Reactor Regulation. However, prior to issuing its decision the Board shall have authority to require staff to inform it of the detailed steps staff believes necessary to implement actions the Board may require and to approve or disapprove of the adequacy of such measures. With respect to any uncompleted items the Board shall have authority similar to that provided in 10 CFR 50.57(b) to take such actions or to impose such limitations or conditions as it believes necessary to protect the public health and safety: Provided, that, as provided elsewhere in this order, restart shall not be permitted until satisfactory completion of all uncompleted short-term actions. Any affirmative determination by the Director will be based upon his finding that the actions specified by the Board, or by the Commission on review, have been taken, that the specified implementing

procedures employed are appropriate, that the licensee satisfies the financial qualification criteria imposed on an applicant for an operating license, and that there is reasonable assurance that the facility can safely resume operation.

As noted above, the Atomic Safety and Licensing Board should accord priority to the consideration of matters relating to the need for continued suspension of operating authority. Within the limitations of 10 CFR 50.59 and 2.717(b) of the Commission's regulations, the licensee may commence modifications, such as those recommended above by the Director of Nuclear Reactor Regulation, during the pendency of this proceeding at its own risk.

VI.

If the Licensing Board should issue a decision authorizing resumption of operation upon completion of certain short-term actions by the licensee and a finding that in its judgment the licensee is making reasonable progress toward completion of the long-term actions specified in this order as to which the Commission has issued immediately effective orders against other licensees, and subsequently if staff certifies that those short-term actions have been completed to its satisfaction, the Commission will issue an order within 35 days after such certification deciding whether the provision of this order requiring the licensee to remain shut down shall remain immediately effective. Any motions relating to the lifting of immediate effectiveness must be received by the Secretary of the Commission within 10 days of issuance of the certification, and any responses to such motions must be received by the Secretary 7 days later. The Commission shall issue an order lifting immediate effectiveness if it determines that the public health, safety or interest no longer require immediate effectiveness. The Commission's decision on that question shall not affect is [its] direct appellate review of the merits of the Board's decision.

VII.

By September 4, 1979, the licensee may file a written answer to this Order and any person whose interest may be affected by this proceeding may file a written petition to intervene. Petitions for leave to intervene must be filed in accordance with the Commission's Rules of Practice for Domestic Licensing Proceedings" in 10 CFR Part 2. If a petition for leave to intervene is filed by the above date, the Atomic Safety and Licensing Board established by this Order will rule on the petition and issue an appropriate further order. An order wholly denying a petition for leave to intervene shall be appealable by the petitioner to the Commission itself within ten days after service of the order. An order granting a petition for leave to intervene shall be appealable to the Commission itself by a party other than the petitioner on the question of whether the petition should have been wholly denied.

As required by 10 CFR 2.714, a petition for leave to intervene shall set forth with particularity the interest of the petitioner in the proceeding, and how that interest may be affected by the results of the proceeding. The petition should specifically explain the reasons why intervention should be permitted with particular reference to the following factors:

(1) the nature of the petitioner's right under the Atomic Energy Act to be made a party to the proceeding;

(2) the nature and extent of the petitioner's property, financial, or other interest in the proceeding; and

(3) the possible effect of any order which may be entered in the proceeding on the petitioner's interest.

The petition should identify the specific aspect(s) of the subject matter of the proceeding as to which petitioner wishes to intervene.

Not later than fifteen days prior to the first prehearing conference scheduled in the proceeding, the petitioner shall file a supplement to the petition to intervene which must include a

list of contentions which are sought to be litigated in the matter, and the bases for each concern set forth with reasonable specificity. A petitioner who fails to file such a supplement which satisfies these requirements with respect to at least one contention will not be permitted to participate as a party.

An answer to this Order or petition for leave to intervene should be filed with the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Section, or may be delivered to the Commission's Public Document Room, 1717 H Street, N.W., Washington, D.C. by September 4, 1979. A copy of the petition should be sent to the Executive Legal Director, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555 and to Mr. George F. Trowbridge, Shaw, Pittman, Potts and Trowbridge, 1800 M Street, N.W., Washington, D.C. 20036, attorney for the licensee. Any questions or requests for additional information regarding the content of this Notice should be addressed to the Chief Hearing Counsel, Office of the Executive Legal Director, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

Nontimely filings of petitions for leave to intervene, amended petitions or supplemental petitions will not be entertained absent a determination that the petitioner has made a substantial showing of good cause for the granting of a later petition. That determination will be based on a balancing of the factors specified in 10 CFR 2.714(a)(i)-(v) and 2.714(d).

VIII.

Copies of the following documents are available for inspection at the Commission's Public Document Room at 1717 H Street, N.W., Washington, D.C. and are being placed in the Commission's local public document room at the State Library of Pennsylvania, Government Publications Section, Education Building, Commonwealth and Walnut Streets, Harrisburg, Pennsylvania 17126.

August 1 Commission Order

April 16 Ltr. Herbein to Denton (prior notice will be given before restart)

June 28 Ltr. Herbein to Denton (modifications to be completed before TMI-1 restart)

June 28 NRC Staff Meeting summary on TM-1 restart

NUREG-0578

I&E Bulletins 79-05A
79-05B
79-05C

FOR THE COMMISSION

Samuel J. Chilk
Secretary of the Commission

Dated at Washington, D.C.
this 9th day of August, 1979.

ATTACHMENT

Milestone	Time Consumed Days	Total Days Into Proceeding
Publication of Notice (Detailed Order)	0	0
Filing of Intervention Petitions	20	20
Answers to Petitions	15	35
Time for Amending Petitions and for Negotiations re Contentions	25	60
Time between filing Amended Petitions and Contentions and Special Prehearing Conference	15	75
Publication of Special Prehearing Conference Order	5	80
(Discovery begins)		
Discovery completed	60	140
During discovery period:		
-Objections to Special Prehearing Conference Order 10 days		
-Possible further refinement of contentions		
Prehearing Conference	—	140
Prehearing Conference Order	5	145
Filing of Testimony	20	165
(Assumes objections to prehearing Conference Order filed simultaneously)		
Begin Hearings	15	180
Complete Hearings	60	240
Filing of Proposed Findings	40	280
Reply to Proposed Findings	10	290
Decision by Board	45	335

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

Docket No. 50-289 (Restart)

In the Matter of METROPOLITAN EDISON COMPANY, *et al.*, (Three Mile Island Nuclear Station, Unit No. 1)

PEOPLE AGAINST NUCLEAR ENERGY PRELIMINARY PLAN FOR PRESENTATION OF EVIDENCE ON PSYCHOLOGICAL DISTRESS

People Against Nuclear Energy (PANE) is in the early stages of developing the case that it will present on the issue of psychological distress. PANE has spoken to several potential expert witnesses and has investigated the various studies that have been or are now being done on the issue. On the basis of these discussions and investigations, PANE submits the tentative plan for presentation of evidence set out below.

PANE's case on psychological distress will consist of four parts: (1) evaluation of studies done by others on the psychological impacts of the accident, (2) presentation of a comprehensive study to be done by PANE's expert witnesses on impacts in the area within five miles of TMI, (3) testimony of individuals concerning their own experiences, and (4) the conclusions of PANE's expert witnesses concerning the psychological and community health impacts of the TMI Unit 2 accident and of the renewed operation of TMI Unit 1.

In addressing existing and ongoing studies PANE's experts will evaluate the quality of each study and how the study's conclusions relate to the particular issues in this case. They will also explain the additional information that is needed in order to reach valid conclusions on the issues before the NRC.

In order to provide that additional information and to assure that the interests of its members and their neighbors and

communities are considered, PANE expects to conduct a comprehensive evaluation of psychological and community health impacts in the area within five miles of the reactors. This will be accomplished either by canvassing large numbers of residents or by selecting a smaller number through a sampling process. The choice depends upon the resources available to PANE and upon the advice of PANE's experts. In either case, the study will involve thorough psychological evaluation through both standardized testing and intense individual interviews. In addition, PANE will present evidence concerning property values, population changes, vandalism, business decline, and other indicia of community health.

The third part of PANE's presentation will be the testimony of area residents about their experiences since the accident and their reactions to the possible renewed operation of TMI Unit 1. These witnesses will provide the Licensing Board with a representative sample of the psychological effects found by the various studies and by PANE's experts.

Finally, PANE's experts will discuss their conclusions concerning both the long and short-term psychological and community health impacts of the accident itself and of the proposed restart of TMI Unit 1.

In presenting this plan, PANE emphasizes that it is tentative and may change significantly before the hearing begins. The Report of the President's Commission on the Accident at Three Mile Island, which includes a study on behavioral impacts of the accident, has only just been released, and other studies have not yet been completed. In addition, PANE has not been able to finalize arrangements with expert witnesses because the Commission has not yet decided to consider these

issues. For that reason, this can only be considered as a tentative outline of PANE's presentation.

Respectfully submitted.

/s/ William S. Jordan, III
WILLIAM S. JORDAN, III

/s/ Karin P. Sheldon
KARIN P. SHELDON
SHELDON, HARMON & WEISS
1725 I Street, N.W.
Suite 506
Washington, D.C. 20006
(202) 833-9070

DATED: November 2, 1979

11 NRC 297 (1980)

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Ivan W. Smith,, Chairman
Dr. Walter H. Jordan
Dr. Linda W. Little

Docket No. 50-289
(Restart)

In the Matter of

METROPOLITAN EDISON COMPANY

(Three Mile Island Nuclear Station, Unit No. 1)

February 22, 1980

Responding to the direction of the Commission that the Licensing Board certify to it, prior to issuance by the Board of a prehearing conference order pursuant to 10 CFR 2.752(c), any contentions raised by the parties relating to issues such as psychological distress arising from the impacts of the TMI-2 accident, the Licensing Board refers to the Commission the various contentions raised and the briefs submitted by the parties on the matter. In its certification, the Board concludes that the Commission, within its discretion, may and should consider psychological stress and community fears under NEPA for the purpose of mitigating the effects of its TMI-1 licensing activity.

CERTIFICATION TO THE COMMISSION ON PSYCHOLOGICAL DISTRESS ISSUES

I. Background

In its Order and Notice of Hearing dated August 9, 1979 the Commission stated that it had been unable to determine whether issues such as psychological distress arising from the impacts of the TMI 2 accident can be relevant to this proceed-

ing. Parties wishing to raise such issues were invited to brief these issues to the Licensing Board under the Atomic Energy Act and National Environmental Policy Act. The Board was directed to certify the matter of [to] the Commission, ". . . either with or without its recommendation on such issues . . ." before the Board's prehearing conference order pursuant to 10 CFR 2.752(c). The Commission also stated that it would consider whether it can or should grant financial assistance to parties seeking to raise these issues. 10 NRC 141, 148. *Federal Register* 47821, 47824, August 15, 1979.

The board provided for the filing of psychological stress contentions and briefs and we requested preliminary plans for the presentation of evidence on psychological issues.[1] Subsequently seven intervenors filed psychological stress contentions.[2] The Commonwealth of Pennsylvania and four intervenors filed briefs favoring psychological stress issues[3] and two intervenors filed preliminary plans for the presentation of

---

[1] Memorandum and Order Ruling on Petitions and Setting Special Prehearing Conference, September 21, 1979, pp. 23, 24. Subsequently two intervenors objected to the request for a preliminary plan for psychological evidence. The Board removed any deadline for the filing of preliminary evidence plans, explained that it was an invitation to the parties, not an order, and we explained the purpose of the request. Memorandum and Order on Motions to Modify, October 16, 1979.

[2] People Against Nuclear Energy (PANE) Contentions Nos. 1 and 2; Newberry Township TMI Steering Committee, *et al.* (Newberry Intervenors) Contentions Nos. 1 and 2; Three Mile Island Alert, Inc. (TMIA) Contentions Nos. 3 and 8; Environmental Coalition on Nuclear Power (ECNP) Contention No. 6; Chesapeake Energy Alliance (CEA) Contention No. 4; Steven Sholly Contention No. 12; Aamodts Contention No. 9.

[3] Commonwealth's brief, October 4, 1979, PANE's main brief, October 22, 1979, Newberry Intervenors, brief, October 19, 1979. In addition, TMIA's petition to intervene, September 12, 1979, p. 7, and Mr. Sholly's Supplement to petition to intervene, pp. 38-40, October 22, 1979 contain arguments on the issue.

psychological stress evidence.[4] The licensee and the staff each filed briefs opposing issues of psychological stress.[5] PANE filed a brief in reply to the briefs of licensee and staff and filed a request for financial assistance to support intervention on psychological issues.[6] All of the relevant contentions and briefs by the parties are appended. The briefs of the Commonwealth, PANE, licensee and staff are extensive and together they present a reasonably thorough discussion of the issues. In our view they include the points made by intervenors Newberry, TMIA, and Mr. Sholly whose briefs were short and rather summary.

II. Summary of Certification

In this certification the board directly refers the briefs of the parties to the Commission. We do not brief again the issues; our discussion is limited to areas where we believe the briefing by the parties fell short of a complete discussion of the relevant considerations. We also make a recommendation and some observations about this particular proceeding. The staff's brief is a well-organized and reasoned presentation. Although we disagree with some of the staff's conclusions, we have used it as the foundation for our comments.

Below we state that psychological stress is probably not cognizable under the Atomic Energy Act but that the Commission might conclude to the contrary for reasons not discussed by the parties. We believe that NEPA permits the NRC to consider community fears. We recommend that we be permit-

---

[4] Newberry Intervenors' preliminary plan, October 22, 1979. PANE preliminary plan, November 2, 1979.

[5] Staff brief, October 31, 1979, Licensee opposition brief, October 31, 1979.

[6] PANE's reply brief, November 7, 1979, PANE's request for financial assistance, November 29, 1979. In addition, on February 1, 1980, PANE filed a request for an expedited decision on its request for financial assistance.

ted to include such issues in this proceeding for the purpose of directly reducing the causes of psychological stress; for example, by improving the dissemination of accurate and trusted information. We do not make a recommendation that psychological stress be factored into a full cost/benefit balancing in an Environmental Impact Statement (EIS) because *inter alia* we can identify no basis to believe that it can be done in this case. We were not invited to make a recommendation on intervenor funding, and we make none. However, we comment briefly on the possible use of intervenor funding in this proceeding.

III. Psychological Stress Under The Atomic Energy Act

PANE is the only intervenor to argue that psychological stress is a consideration of "public health and safety" within the purview of the Atomic Energy Act (PANE's main brief, pp. 3-7; reply brief, pp. 3-5). Staff and Licensee each argue that the Act does not encompass any consideration of public health other than health relating to radiation hazards (Staff brief, pp. 3-8; licensee brief, pp. 3-10). The parties discuss *State of New Hampshire* v. *Atomic Energy Commission*, 406 F.2d 170 (1st Cir. 1969), *cert. denied*. 395 US 962 (1969) and *Consolidated Edison Company of New York* (Indian Point, Unit 1) 3 AEC 62 (1965). These cases held that the possible effects of water heated by radiation were not hazards included in the Commission's responsibility to protect the health and safety of the public. The legislative history cited by the staff and licensee also support the view that only radiation hazards are to be considered under the Act. We can identify no law to the contrary.

However, the discussion is incomplete without the observation that, in this case, the intervenors are asserting that radiological hazards associated with accident conditions are affecting mental health. This is to be compared to pollution effects deriving from water heated by radiation in normal operation. This is a case of first impression not specifically addressed by the cited legislative history nor in *New Hampshire* or *Consolidated Edison, supra*. As such, the Commis-

sion's judgment as to whether the alleged health effects fall within the Atomic Energy Act would be entitled to deference. This was the view of the First Circuit in *Public Service Company of New Hampshire* v. *NRC*, 582 F.2d 77 (1978), where the court held:

> In a regulatory scheme where substantial discretion is lodged with the administrative agency charged with its effectuation, it is to be expected that the agency will fill in the interstices left vacant by Congress. *See Phillips Petroleum Company* v. *Wisconsin*, 347 U.S. 672, 74 S.Ct. 794, 98 L.Ed. 1035 (1954); *Henry* v. *FPC*, 168 U.S. App. D.C. 137, 144, 513 F.2d 395, 402 (1975). The Atomic Energy Act of 1954 is hallmarked by the amount of discretion granted the Commission in working to achieve the statute's ends. The Act's regulatory scheme "is virtually unique in the degree to which broad responsibility is reposed in the administering agency, free of close prescription in its charter as to how it shall proceed in achieveing the statutory objective." *Siegel* v. *AEC*. 130 U.S. App. D.C. 307, 312, 400 F.2d 778, 783 (1968). The agency's interpretation of what is properly within its jurisdictional scope is entitled to great deference, *Power Reactor Company* v. *Electricians*, 367 U.S. 396, 408,81 S.Ct. 1529, 6 L.Ed.2d 924 (1961); *Nader* v. *NRC*, 168 U.S. App. D.C. 255, 265-66, 513 F.2d 1045, 1055-56 (1975), and will not be overturned if reasonably related to the language and purposes of the statute. *Hardin* v. *Kentucky Utilities Company*, 390 U.S. 1, 8, 88 S.Ct. 651, 19 L.Ed.2d 787 (1968); *NLRB* v. *Hearst Publication*, 322 U.S. 111, 131, 64 S.Ct. 851, 88 L.Ed. 1170 (1944); *Bangor and Aroostock Railway Company* v. *ICC*, 574 F.2d 1096, 1104 n.8 (1st Cir. 1978).

Id. p. 82.

In *Public Service Company* (a phase of the famous *Seabrook* proceeding), the court was referring not only to the Commission's discretion under the Atomic Energy Act but also to the deference due the Commission's "interpretation of what is properly within its jurisdictional scope" under NEPA. *Ibid.* We again address the Commission's discretion under NEPA below.

IV. Psychological Stress Is Cognizable Under NEPA

The parties opposing the view that psychological stress may be considered under NEPA do so on three major bases: 1) The requisite nexus of a direct physical environmental impact to the psychological stress is not present, 2) psychological stress is not measurable, thus cannot be counted under NEPA, and 3) even if psychological stress were to be measurable, it cannot be considered in the asserted absence of a rational basis for the effect. We discuss each of these considerations in the order of the Staff's discussion (Staff brief, pp. 29-50).

A. Direct Physical Impact is Required

In its brief the staff acknowledges that certain types of "social" or "indirect" impacts must be considered under NEPA but only when it has first been demonstrated that these indirect impacts are a result of a direct impact upon the physical environment (pp. 30-41). In support of this position the staff refers to the Act itself (p. 31), the legislative history (pp. 31-33) a line of court decisions (pp. 34-39) and the Council of Environmental Quality regulation, 44 CFR 1508.14, (pp. 39-41).

There is no closely analogous portion in the licensee's brief but the concept is related to the licensee's discussion of its view that the *bases* for community fears must be addressed, not the *fears* themselves. (e.g. pp. 31-33) This view is more appropriately considered below under our discussion of whether psychological stress must be rationally based before it may be considered. Neither the intervenors nor the Commonwealth discuss staff's "direct physical impact" argument. Even though PANE's reply brief addressed most of the staff's objections to psychological issues, it did not reply to the "direct physical impact" argument (p. 6).

The cases relied upon by the staff in its "direct physical impact" argument are representative of those involving a direct socio-economic impact not based on a significant physical impact upon the environment. Typically in these cases the

armed forces undertake to close, relocate, or reduce operations at a military facility with a result [resulting] loss of jobs or other adverse economic effect upon the surrounding community (*e.g. Breckinridge* v. *Rumsfield*, 537 F.2d 864 (6th Cir. 1976), *cert. denied* 429 U.S. 1061 (1977), Staff Brief, pp. 34-38. In another case, *Monarch Chemical Works, Inc.* v. *Exxon*, 466 F.Supp. 639 (D. Neb., 1979), the court held that since a correctional facility would have no significant primary effect, consideration of socio-economic effects was not required. The CEQ regulation, 10 CFR 1508.14, provides that social effects in themselves do not require an EIS, but must be considered when interrelated with natural or physical environmental effects.

Since no one else has done so it is necessary for us to point out that these cases are irrelevant to this proceeding. The psychological stress alleged by the intervenors here is related to a significant physical environmental impact: the operation of TMI 1 coupled with residual effects of the accident at TMI 2. It does not matter, as staff argues, that there has been a cost/benefit balancing in a full-scale EIS for TMI 1 and the construction and operation was found to be justified (pp. 9-14) or that this is a narrowly scoped proceeding. The very fact that an EIS and cost/benefit balancing was required is a recognition of the fact that the operation of TMI 1 involves a significant physical impact upon the environment.

B. Psychological Stress is Sufficiently Quantifiable

The staff (pp. 43-47) and other parties cite five Circuit Court cases to the effect that community fears and psychological stress are not cognizable under NEPA primarily because they are not amenable to quantification: *Hanly* v. *Mitchell*, 460 F.2d 640 (2d Cir. 1972), *cert. denied*, 409 U.S. 990 (1972) *(Hanly I); Hanly* v. *Kleindienst*, 471 F.2d 823 (2d Cir. 1972), *cert. denied*, 412 U.S. 908 (1973) *(Hanly II): Maryland-National Capital Park and Planning Commission* v. *U.S. Postal Service*, 487 F.2d 1029, 1037-38 (D.C. Cir. 1973); *First National Bank of Chicago* v. *Richardson*, 484 F.2d 1369, 1375 (7th Cir. 1973); and *Nucleus of Chicago Homeowners Associa-*

tion v. *Lynn*, 524 F.2d 225 (7th Cir. 1975) *cert. denied*, 424 U.S. 967 (1976).[7]

The quantifiability cases are the focal point of the most vigorous debate among the parties and this sub-issue is extensively discussed by all those briefing the issue. Licensee brief, pp. 13-29; PANE main brief, pp. 16-21; PANE reply brief, pp. 9-12; Commonwealth brief, *passim*, Newberry Intervenors' brief, pp. 2-4.

The intervenors, particularly PANE and Newberry Intervenors, discuss in their filings how psychological stress may be measured in individuals and in the community. The discussion frequently is based upon tort *liability*, thus, to some extent, it becomes digressive. But addressing the *measurability* of psychological stress in terms of torts [is] relevant to the limited use recommended by the board below. The staff acknowledges that some quantification of stress upon the community is being undertaken by responsible organizations. Staff brief, p. 53, n. 51. Although we discuss the possible uses of this information below, we have nothing to add to the parties' briefs on how to measure psychological stress.[8]

However the consideration of whether psychological stress is sufficiently quantifiable to be considered under NEPA should also include several factors not addressed by the parties.

Precise numerical quantification is not necessary. The NRC regularly considers the aesthetic effects of its licensing actions

---

[7] *But See Chelsea Neighborhood Association* v. *U.S. Postal Service*, 516 F.2d 378, 388 (2d Cir. 1975).

[8] Except that we might note that it is premature to expect parties to describe now the details of their expected evidence. The intervenors have, in our view, established a sufficient prehearing basis for the premise that the effects are measurable. To permit this evaluation is why we invited preliminary plans for the presentation of evidence on psychological stress, n. 1, *supra*.

upon the environment. Recently, the NRC staff concluded in *Greene County Nuclear Power Plant* that the proposed nuclear plant would have an unacceptable aesthetic impact upon the environment surrounding the proposed plant. Final Environmental Statement (FES),NUREG-0512, January 1979, p. IV., Sec. 5.7. The staff's non-numerical measurement of the Greene County plant's aesthetic impact has apparently eliminated the proposed site; the applicant has not challenged the staff's findings. The licensing board in *Public Service of New Hampshire, et al.*, (Seabrook Station, Units 1 and 2), 6 NRC 816, 826, in a finding later mooted, measured the aesthetic impacts of cooling towers for the Seabrook facility. *Id.* at 826.

In a later phase of that same proceeding, the First Circuit in *Public Service Company, supra*, found that the NRC was well within its discretion in requiring the rerouting of transmission lines, in part, to avoid a "visual insult" to the relatively pristine area involved (582 F.2d at 80).

Another point not adequately briefed is that, in the quantifiability cases argued by the parties, no mention is made of the posture of the cases there compared with here. In the *Hanly* cases, *supra*, *Maryland National Capital Park and Planning Commission, supra; First National Bank of Chicago, supra; Nucleus of Chicago Homeowners, supra;* and virtually every other case discussed by the parties concerning the requirements of an EIS, the Federal agency has been sued for an asserted failure to comply with the provisions of NEPA. But in *Public Service Company, supra*, the NRC was challenged by the utility for exceeding the requirements of NEPA. In this unusual, perhaps unique situation, the exercise of the agency's discretion in affirmatively protecting the environment was ringingly supported by the court. *See* citation, pp. 5, 6, *supra* and 582 F.2d at 82.

Still another aspect of the quantifiability subissue not adequately addressed by the briefing parties is the nature of the impacting force. In the *Hanly* line of cases, and those following, the courts were confronted with the argument that the

mere presence of a disadvantaged group of people could constitute a pollution to the environment of a higher socio-economic group. The term "people pollution" was disparangingly [*sic*] coined by Judge Leventhal of the D.C. Circuit in *Maryland National Capital Park and Planning Commission*, *supra*, 487 F.2d, at 1037. The D.C. Circuit refused to accept a factor with such strong racial and class overtones as a consideration of national environmental policy. The Seventh Circuit in *Nucleus of Chicago Homeowners Association*, 524 F.2d at 231, cited with approval the D.C. Circuit refusal. See also *Como-Falcon Coalition* v. *Department of Labor*, 465 F.Supp. 850, 857, n. 2 (D.Minn. 1978). In our proceeding of course there are no overriding national policies preventing the frank acknowledgment that the presence of the impacting force (operation of TMI 1) in itself may be considered in mitigation of its effects, which brings us to the next area of dispute among the parties.

C. Rational Basis for Community Fears

The licensee to a greater extent (brief, pp. 20-25) and the staff to a lesser extent (pp. 44-46) argue that, even if psychological stress to the community is measurable, it is not cognizable under NEPA if the fears are not justified. Both cite *First National Bank of Chicago*, *supra*, where the court held:

> . . . we question whether such factors, [psychological and sociological effects upon neighbors] even if amendable [*sic*] to quantification, are properly cognizable in the absence of clear and convincing evidence that the safety of the neighborhood is in fact jeopardized.

484 F.2d at 1380 n. 13.

From this ruling, licensee argues that *First National Bank* provides explicit support for the proposition that unsubstantiated fears or unfounded psychological effects are not cognizable under NEPA (Licensee brief, p. 22). Neither PANE, the Commonwealth, nor any other intervenor directly addresses this view of NEPA, so we must.

First, "clear and convincing" is a standard for the measurement of proof, the quantity and quality of evidence; its use in *First National Bank*, certainly was not intended to be a carefully considered evaluation of evidentiary standards.

More important is the fact that the scheme of nuclear energy regulation assumes that commercial energy reactors are inherently dangerous but potentially safe. Why else does the Commission consider remote siting of nuclear plants and ten mile plume emergency planning zones? For that matter, why else are there an Atomic Energy Act and the NRC? The TMI 2 Lessons Learned Task Force Final Report states that "probably" the single most important human factor with which the nuclear industry and NRC must contend is the "mind set that future accidents are impossible." NUREG-0585, 1979, p. 2-7.

We urge the Commission to reject out-of-hand the arguments that the Commission should ignore community fears of TMI 1 operation because of the assertion that those fears are irrational. These fears differ from the fears produced by low income housing, and they are more amenable to mitigation as we discuss below.

D. Environmental Impact Statement

In sum the staff's position is that the issue of psychological stress should be considered under the umbrella of a need *vel non* of an environmental impact statement. Staff brief pp. 9-29.[9] The staff argues that an EIS is not required, but even if it were required, psychological stress is probably not cognizable under NEPA. But, according to the staff, maybe it is cogniz-

---

[9] The staff has elected to address the issue of the need for an EIS in its psychological stress brief. The other parties have raised the EIS issue with respect to other sub-issues in briefs not before the Commission. The question of the need for a general EIS is pending before the board.

able. If it is a question of quantifiability, the staff's reasoning continues, it is the NRC's responsibility under NEPA to:

> (B) identify and develop methods and procedures, in consultation with the Council on Environmental Quality established by subchapter II of this chapter, which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decisionmaking along with economic and technical considerations;

Section 102(2)(B); 42 USC 4332 (B). Staff brief, pp. 9-29, 51-56.

Recognizing that NEPA may require the staff to develop the methods (with CEQ) to quantify "presently unquantified environmental amenities" the staff then reports:

> Further, the NRC Staff has not had the opportunity and does not presently have the expertise to make more than a cursory evaluation of the methodology of these studies. Consequently, we cannot say with any degree of certainty whether the psychic distress associated with continued operation of the TMI 1 facility is sufficiently susceptible of measurement to permit a meaningful assessment of the phenomenon. [footnote omitted]

The staff refers to a sizeable group of studies by responsible organizations attempting to measure the effect of the TMI 2 accident on mental health (Brief, p. 53 n. 51) and other efforts to reconcile mental health with NEPA *(Id.*, p. 54, n. 53). But its ultimate conclusion is that psychological stress should not be considered in this proceeding. *Id.*, p. 56.

We have examined the filings of the parties, the studies referred to by the staff, and other literature.[10] We cannot

---

[10] For example, (1) Gleser, G. C.; Green, B. L.; and Winget, C. N. 1978. "Quantifying Interview Data on Psychic Impairment of Disaster Survivors." *Journal Nervous and Mental Disease, 166(3)*, 209-216; (2) Quarantelli, E. L., and Dynes, R. R. 1977. "Response to Social Crisis and Disaster." *Annual Review of Sociology*, 3, 23-49 (a review of the state-of-the-art of disaster psychology/sociology, with a bibliography of more than 100 references; (3) Quarantelli, E. L.

identify a source of evidence which would permit the measurement of the psychological stress phenomenon well enough for use in a full-scale cost/benefit balancing in an EIS. Nor do we know whether or not the state of the art can now produce such evidence. Although the intervenors refer to the community fears as well as individual fears, the intervenors have no more resources or expertise than does the staff to produce evidence useful in a full-scale cost/benefit balancing.

Only the staff has the resources and opportunity to develop the methodology to produce such evidence. Whether the staff should be directed to develop the methodology to quantify psychological stress for use in an EIS is a matter between the Commission and the staff. The board has no recommendation.

E. Mitigation under NEPA

It was appropriate for the staff to discuss psychological stress first in terms of an EIS, but the staff erred in limiting its analysis to whether an EIS factoring psychological stress is required.

Aside from its fundamental threshold position, the staff seems to take the position that, even if psychological distress is cognizable under NEPA, the Commission cannot consider it because it does not have the skills and resources to factor it precisely into an EIS. Thus, it would seem, the staff is arguing that, if the Commission cannot do a complete job, it should do nothing at all. We disagree. We believe that NEPA permits the NRC, within its discretion and *without an EIS*, to consider community and individual fears, and to take reasonable actions to mitigate these fears.

It is true that the NRC usually considers environmental impacts in the course of issuing an EIS or environmental

---

(ed.), 1978, *Disasters: Theory and Research*, Sage Studies in International Sociology 13. Journals include *Mass Emergencies: An International Journal of Theory, Planning, and Practice* and *The International Journal of Disaster Studies and Practice*.

impact appraisal under Section 4332(C). Sometimes the evaluation is under subsection (E) requiring the consideration of alternatives.[11] But solely because an action otherwise required by NEPA does not fall neatly into the specific mandates of Section 4332 (A) through (I), does not, in our view, prevent the Commission from exercising its general authority and responsibilities under NEPA.

In Section 4332:

> The Congress authorizes and directs that, to the fullest extent possible: (1) the policies, regulations, and public laws of the United States shall be interpreted and administered in accordance with the policies set forth in this chapter, . . .

The policies referred to are those set forth under Section 4331(b) including:

> (2) assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings;
>
> (3) attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;
>
> (5) achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; . . .

These general provisions of NEPA provide the Commission with the authority to take reasonable action to protect the environment even where an EIS is not required, or as it may be

---

[11] Section 4332 (E) requires agencies to ". . . study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources; . . ."

We do not depend upon this subsection because we believe that the Commission's authority to protect the environment is much more fundamental.

in this case, not possible. In a review of NRC and AEC decisions we have been unable to find specific authority for our view. The cases, as we noted above, have been under circumstances where the impact has been deemed sufficient to trigger an EIS under Section 4332(C) (or a negative statement supporting an environmental impact appraisal). However there is no trend that we can identify in Commission-NEPA precedents inconsistent with our recommendation. The conditioning of licenses has not been dependent upon whether, in a cost/benefit balancing, the overall balance was tipped. In *Detroit Edison Company* (Greenwood Energy Center, Units 2 and 3) ALAB-247, 8 AEC 936, 944-45 (1974), the Appeal Board discussed the relationship between the Commission's authority to condition licenses and the final balancing under NEPA:

> Nor is the Commission's authority restricted, as the applicant would have it, to voting the license up or down depending on whether the overall "cost/benefit ratio" is tilted against the facility by the location of its transmission lines. On the contrary, under NEPA, an agency is also obliged to minimize to the extent reasonably practicable the environmental aftermath of its actions. *Environmental Defense Fund* v. *Corps of Engineers*, 492 F.2d 1123, 1135 (5th Cir. 1974); *Environmental Defense Fund* v. *Froehlke*, 473 F.2d 346, 353 (8th Cir. 1972); Council on Environmental Quality Guidelines, 40 CFR Section 1500.2(b) (1974 rev.). [Footnote omitted] As the District of Columbia Circuit has succinctly put it:
>
> > Clearly, it is pointless to 'consider' environmental costs without also seriously considering action to avoid them. [*Calvert Cliffs, supra*, 499 F.2d at 1128.]
> >
> > Our own decisions reflect that understanding. We have held that NEPA requires nuclear facilities to be designed to minimize environmental harm to the extent reasonably practicable before the final balance is struck. The cooling tower cases are a clear example. We have reiterated in those decisions that the relative environmental merits and costs of the various cooling systems be evaluated for each facility to insure "that the optimum alternative may be selected" before "[f]inally, an overall balancing of costs and benefits occurs . . ."

> [Citations omitted] It would overturn those decisions to rule in this case that environmental damage which can be avoided at reasonable cost is nonetheless permissible, provided only that the ultimate, overall cost/benefit ratio remains favorable to a nuclear plant. Such a result is unwarranted; it would devitalize NEPA. We are neither prepared nor empowered to inter that Act.

Id. at 444-45.

In *Public Service Company, supra,* the First Circuit described the reach of NEPA quite simply:

> The directive to agencies to minimize all unnecessary adverse environmental impact obtains except when specifically excluded by statute or when existing law makes compliance with NEPA impossible.

582 F.2d at 81.

As we noted, the board, if permitted, would consider psychological stress for the purpose of mitigating community fears about the operation of TMI 1. The licensee notes throughout its brief that the correct way to address community fears is to remove the bases for them (Licensee's brief, e.g., pp. 18, 23, 30-33). Certainly it is true that the best way to minimize any psychological stress in the communities around TMI 1 is to make the plant safe or not allow it to operate. We do not need further authority from the Commission to approach community fears in this manner. What we may need is the jurisdiction to impose reasonable, cost-effective conditions on the operation of TMI 1 directly, and perhaps solely, for the purpose of mitigating psychological stress. For example, if the record should demonstrate that the licensee has complied with the law, regulations and reasonable standards of public health and safety in its radiological monitoring program, but that, say, additional continuous off-site monitoring visible by the residents around the facility would reduce apprehension in the community, and, in a minicost/benefit balancing, it is found to

be reasonable, we should have the authority under NEPA to require this amenity.[12]

Further, the opportunity for the public in the vicinity of TMI to express through the NRC hearing process their fears and ideas for the alleviation of their fears can in itself have a substantial mitigating impact in the resolution of any residual psychological stress from the accident, and the proposed restart of TMI 1. On the other hand, to conclude summarily that these fears are baseless and therefore beyond NRC jurisdiction, as urged by the licensee, may produce additional stress in that the public may perceive an attitude that their fears are of no consequence, and that, therefore they have no control over, or voice in the events affecting them.[13]

Even if the Commission does not permit the consideration of psychological stress issues as such, these issues may collaterally relate to other issues which must be considered in the proceeding. Community fears may be a factor in evaluating the effectiveness of the licensee's emergency response plan. The licensee's sensitivity to community fears and licensee's credibility may indirectly relate to its management capability to formulate and implement emergency response plans. Conversely, the effectiveness of plans may rest on the public's education, its preparation to take action and its confidence in the plans. To the extent that psychological stress may be a factor in these other issues, we do not believe that additional authority from the Commission is required. We are seeking only the authority to address directly and to mitigate fears which may result from the proposed operation of the facility.

---

[12] This example has no record basis. We use it solely as an illustration. It is, however, an area of interest to the board which may deserve examination.

[13] Titchener, J. L. and F. T. Kapp, 1976. "Family and Character Change at Buffalo Creek." *American Journal Psychiatry, 133*(3), 295-299; Lifton, R. J. and E. Olson, 1976. "The Human Meaning of Total Disaster: The Buffalo Creek Experience." *Psychiatry, 39*, 1-18.

The board would not anticipate a parade of witnesses describing their personal experiences during the TMI 2 accident and their concerns about restarting TMI 1.[14] This approach would soon become cumulative and, in any event, would be of doubtful value. It would provide little information beyond what the board has already observed during the public limited appearances. As we noted above, the staff's brief contains references to studies which may be valuable and individual intervenors have indicated their plans to approach the issue on a broader, more analytical level.

V. Intervenor Funding

The Commission has not invited the board's recommendation on the issue of financial assistance to intervenors. While we do have views on the subject, they are individual and philosophical, and not likely to be helpful to the Commission. Our only comment on intervenor assistance is that there are intervenors and attorneys in this proceeding who have the skills to use intervenor funds effectively. One intervenor, PANE, has submitted a plan for the use of intervenor funds which warrants consideration if the Commission determines to provide intervenor assistance (p. A-133).

---

[14] The Consumer Advocate of Pennsylvania has submitted an instructive brief addressing the potential problems of stress caused to witnesses testifying on this subject (p. A-28).

VI. CONCLUSION

The Nuclear Regulatory Commission, within its discretion, may and should consider psychological stress and community fears under NEPA for the purpose of mitigating the effects of its TMI 1 licensing activities.

Respectfully submitted,

THE ATOMIC SAFETY AND
LICENSING BOARD
WALTER H. JORDAN
LINDA W. LITTLE
IVAN W. SMITH, Chairman

Bethesda, Maryland,
February 22, 1980

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

MAR 27 1981

Docket No. 50-289

MEMORANDUM FOR: James R. Tourtellotte, Assistant Chief Hearing Counsel, Office of the Executive Legal Director

FROM: Wm. H. Regan, Jr., Chief
Siting Analysis Branch
Division of Engineering

SUBJECT: TRANSMITTAL OF AN ENVIRONMENTAL IMPACT APPRAISAL RELATING TO THE PROPOSED RESTART OF THREE MILE ISLAND, UNIT 1

Enclosed is an Environmental Impact Appraisal relating to the proposed restart of Three Mile Island, Unit 1. This is the document which the Staff, through its legal counsel, stated would be prepared to analyze the environmental impacts likely to result if TMI-1 were allowed to restart.

This staff analysis has not led to the identification of any new environmental impacts or any significant changes in those identified previously. The Staff, therefore, recommends the issuance of a negative declaration.

/s/Wm. H. REGAN, JR.
Wm. H. Regan, Jr., Chief
Siting Analysis Branch
Division of Engineering

Enclosure:
As stated
cc: D. Muller

ENVIRONMENTAL IMPACT APPRAISAL BY THE DIVISION OF ENGINEERING EVALUATING THE PROPOSED RESTART OF THREE MILE ISLAND NUCLEAR STATION, UNIT 1

DOCKET NO. 50-289

ENVIRONMENTAL IMPACT APPRAISAL

I. Description of Proposed Action

Following the Three Mile Island Nuclear Station, Unit No. 2 accident on March 28, 1979, the U.S. Nuclear Regulatory Commission (Commission) ordered that the Three Mile Island Nuclear Station, Unit No. 1 (TMI-1), authorized to operate under Facility Operating License No. DPR-50 (held by Metropolitan Edison Company (the licensee)), remain in a cold shutdown condition until further order of the Commission. The Commission also stated that a hearing would be conducted prior to any restart of the facility. "Order" dated July 2, 1979.

On August 9, 1979, the Commission published an Order and Notice of Hearings (*Metropolitan Edison Co.* (Three Mile Island Nuclear Station, Unit 1), CLI-79-8, 10 NRC 141 (1979) which specified the basis for its concerns and procedures to govern further proceedings. This Order also appointed the members of an Atomic Safety and Licensing Board (Board) to conduct the required hearing.

Pursuant to the above Notice, several petitions to intervene were filed. During the First Special Prehearing Conference held by the Licensing Board on November 9, 1979, the Staff, through its legal counsel, stated that an environmental impact appraisal would be prepared which, if it revealed significant environmental impacts, would cause the Staff to issue either an environmental impact statement or a supplement to the earlier environmental impact statement prepared in conjunction with the initial licensing of the facility. If no significant impacts were found, the Staff would recommend the issuance of a negative declaration. (Tr. 373).

A review of the environmental effects of the proposed restart of TMI-1 has now been completed.[1] Based on this review, the staff concludes that there would be no significant environmental impacts beyond those previously identified and evaluated in the environmental impact statement prepared in conjunction with the initial licensing of the facility should TMI-1 be permitted to resume operation. The bases for this conclusion are set forth below.

II. Environmental Impact Of Proposed Action

The Staff's Final Environmental Statement (FES), relating to the operation of TMI-1 and TMI-2, was issued in December, 1972.[2] Based on its review, the Staff concluded that there would be several adverse environmental effects resulting from the operation of Units 1 and 2. These conclusions were documented in the FES and conditions were imposed on the licensee for the protection of the environment. An operating license, with environmental and other conditions attached, was issued for TMI-1 on April 19, 1974.[3]

In determining the potential effects of the proposed restart, the Staff re-examined the environmental impact of operation of

---

[1] The staff did not examine the psychological stress factor in its environmental review. The Atomic Energy Act of 1954, as amended, and the National Environmental Policy Act of 1969 do not require that such effects be analyzed in an environmental review. See Brief of NRC Staff on Psychological Distress Issues, October 31, 1979. Further, the Commission ruled on December 5, 1980 that psychological stress issues would not be heard in this proceeding. Metropolitan Edison Co. (Three Mile Island Nuclear Station, Unit 1), CLI-80-39, 12 NRC ___ (1980).

[2] The FES was reprinted as Appendix B to the Final Supplement to the Final Environmental Statement related to operation of Three Mile Island Nuclear Station, Unit 2 (NUREG-0112) which was issued in December 1976. The FES was also reprinted as NUREG-0552 in April 1979.

[3] 39 *Fed. Reg.* 14623 (1974).

the TMI Station as discussed in the FES for Units 1 and 2.[4] This re-examination included an evaluation of whether previously identified environmental impacts would be changed in any way should restart be authorized. The impacts reported in the 1972 FES are restated below and are followed by the present staff evaluation of the impacts associated with the proposed restart.

A. Construction and Site Development.

In its 1972 FES for Units 1 and 2 the Staff stated that:

> "Construction and site development has and will cause some temporary disturbance of land onsite and of adjacent waters."

NUREG-0112 at B-1.

Present Staff Evaluation:

All construction relating to Unit 1 which would cause disturbance of land onsite and of adjacent waters is complete. No additional construction or site development relating to Unit 1 restart is occurring or will occur.

B. Liquid Effluents

In 1972 the Staff concluded that:

> "About 36,000 gpm of auxiliary service cooling water and blowdown from the cooling towers will be discharged to the Susquehanna River. This liquid effluent from the Station is approximately 5% of the minimum river flow. The effluent will average 3 degrees F or less above ambient river temperature depending on the season of the year. Following relatively infrequent reactor shutdowns during unusual weather conditions (high air and low water temperatures) the effluent could be as much as 19 degrees F above river ambient for periods not exceeding a few hours."

---

[4] The environmental impacts of TMI-1 and TMI-2 are summarized in Appendix B of NUREG-0112 (pages B-1 and B-2).

The Staff also found that "the thermal discharge of the Station to the Susquehanna River will have a negligible effect in terms of the present use of the river for recreation, municipal water supplies, etc." NUREG-0112 at B-41.

Present Staff Evaluation:

Recent reviews of thermal discharges from Three Mile Island and their effects on Susquehanna River aquatic resources have been performed for the 1977 Unit 2 OL hearing[5] and in connection with the 1979 Unit 2 accident.[6] Those reviews examined the facts of Unit 1 operation (1974-1977) and the operation of Units 1 and 2 (1978-1979).

Operation of the closed-cycle cooling system (two natural draft cooling towers plus one mechanical draft tower) at TMI Unit 1 results in effluent temperature being within only a few degrees of ambient river temperature and in many instances the thermal discharge has been unmeasurable a few meters (<5) from the point of discharge.[7] Effluent temperatures measured during Unit 1 reactor cooldown operations have been

---

[5] NRC Staff Response of C. R. Hickey, Jr. to Licensing Board's Question Relating to Aquatic Impacts. Before the USNRC Atomic Safety and Licensing Board, in the Matter of Metropolitan Edison Company, *et. al.* for Three Mile Island Nuclear Station, Unit 2., 50 p. following transcript page 988, May 2, 1977, Harrisburg, PA.

Affidavit of C. R. Hickey, Jr. dated December 6, 1977, on NRC staff's assessment of the Commonwealth of Pennsylvania's revised 401 Certification thermal effluent limitations. Submitted to the USNRC Atomic Safety and Licensing Board, In the Matter of Metropolitan Edison Company, *et. al.* for Three Mile Island Nuclear Station, Unit 2., 10 p.

[6] Hickey, C. R., Jr. and R. B. Samworth. Non-radiological consequences to the aquatic biota and fisheries of the Susquehanna River from the 1979 accident at Three Mile Island Nuclear Station. USNRC, NUREG-0596. November 1979.

[7] *Ibid.*

lower in ΔT (difference between effluent and ambient river temperatures) than the maxima discussed in the 1972 and 1976 environmental statements.[8] Therefore, the thermal effluents produced during station operation have not resulted in conditions different than previously analyzed. No fish-kills have resulted from operation of TMI.[9]

The spatial extent and size of the thermal discharge plume has been monitored as required by the Environmental Technical Specifications. The plume has been variable in downstream extent (0-1000 m long; or to about 0.6 mile), has been confined to very near the west shoreline of Three Mile Island (0-20 m), and to depths of about 3 m in the center channel of the river, which is approximately 1300 feet (~400 m) wide and 9 feet (~2.7 m) deep at flows of about 10,000 cfs. The 1000 m long and 20 m wide plume represents its maximum measured extent. Normally, the measurable plume has been much smaller and in many cases it has been unmeasurable at the point of discharge, due to effluent temperatures being very close to ambient river temperatures. The wide and shallow nature of the Susquehanna River results in low initial mixing of tributary waters with the river; thus the TMI thermal plume remains close to the shoreline as it moves downstream in the center channel. Even during its maximum size, the plume has been only a few degrees warmer than ambient, and has extended downstream to a point about halfway between the effluent discharge and the junction of Three Mile Island with the York Haven Dam. That

---

[8] *Ibid.*

[9] *Ibid;* NRC Staff Response of C. R. Hickey, Jr. to Licensing Board's Question Relating to Fish Kills. Before the USNRC Atomic Safety and Licensing Board, In the Matter of Metropolitan Edison Company, *et. al.* for Three Mile Island Nuclear Station, Unit 2., 18 p. following transcript page 988, May 2, 1977, Harrisburg, PA.

plume area is a relatively small portion of both the center channel and the river as a whole in the site vicinity.[10]

The most productive spawning and nursery areas of important fishes in the York Haven Pond are in the east and west river channels.[11] The areas of the pond fished most frequently by anglers are upstream of TMI and between Hill, Shelley, and Fall Islands (*i.e.*, the north and northwest portions of the pond).[12] Therefore, the thermal effluent from the nuclear station does not intercept or directly contact those important areas of the pond. In summary, operational monitoring has shown that thermal effluents have been within the limits of those predicted and analyzed during pre-operational NEPA reviews, and that impacts to river biota and fisheries have not occurred.

Thus, since operation of TMI-1 if restart is authorized will be in the same manner as previously evaluated, restart of TMI-1 will have minimal effects on the Susquehanna River biota and fisheries.

C. Evaporation

In its original analysis the Staff found that:

> "About 20,000 gpm of river water will be evaporated from the cooling towers."

NUREG-0112 at B-2. The Staff also stated that:

> "[r]emoval of water at this rate is not expected to have a significant effect on the water balance of the Susquehanna

---

[10] Hickey, C. R., Jr., and R. B. Samworth. Non-radiological consequences to the aquatic biota and fisheries of the Susquehanna River from the 1979 accident at Three Mile Island Nuclear Station. USNRC, NUREG-0596. November 1979.

[11] *Ibid.*

[12] Hickey, C. R., Jr. Assessment of the consequences to the recreational fishery of the Susquehanna River from the 1979 accident at Three Mile Island Nuclear Station. USNRC Draft NUREG-0754. December 1980.

River in the vicinity of the Station since this is a small perturbation of the normal seasonal variation of the river flow (see Section II.E)."

NUREG-0112 at B-40.

Present Staff Evaluation:

In 1977, the Staff was asked whether, in view of the operating experience at TMI-1, there were any changes in the water usage projections for TMI-2 as stated in the FES for Units 1 and 2.[13] At that time, the Staff stated that the figures for water usage previously presented in the FES (pages III-7 through III-11) were still applicable. There were no changes in the water use design values as a result of the operating experience at TMI-1.

To date, there have been no changes in the water use design values as reported in the FES and none are expected as a result of the restart of TMI-1. Because the projections for water evaporation remain unchanged, the above conclusion that water evaporation will not have a significant impact on the water balance of the Susquehanna River would continue to be valid should Unit 1 be allowed to resume operation.

D. Radioactive Releases

The Staff, in the 1972 FES[14], determined that:

---

[13] The Licensing Board presiding over the TMI-2 hearings asked to see "up-to-date data, if there are any changes, on projected water use. That is, volume taken in, consumed, discharged, in proportion or in relation to river stage, particularly in view of the experience of Unit 1 and the projections for Unit 2." Prehearing conference transcript at pp. 144-45. The Staff's response to this concern was presented by Dr. Robert B. Samworth on May 2, 1977. Testimony following transcript p. 988.

[14] The numbers presented in the 1972 FES were for both units at the station. Since Unit 1 is slightly smaller than Unit 2, a division of the numbers by two will give a conservative estimate of the radiation dose from Unit 1 from normal operation. This would be 15 man-rem/year.

> "About 7555 curies of radionuclides in gaseous effluents and 2008 curies of radionuclides in liquid effluents (including 2000 curies of tritium) will be released to the environment annually." NUREG-0112 at B-1.

To put the above information in perspective, the staff further stated that:

> "[U]sing conservative estimates, the annual total man-rem dose from all pathways received by the approximately 1,868,000 people who live within a fifty-mile radius of the plant would be about 31 man-rem. By comparison, an annual total of about 233,000 man-rem to the same population results from an annual average natural background dose of 0.125 rem in the Commonwealth of Pennsylvania.
>
> Operation of the plant will contribute only an extremely small increment of the radiation dose that persons living in the area normally receive from natural background radiation. Normal fluctuations of the natural background dose is expected to exceed the small dose increment contributed by the plant. Thus, the incremental increase will be difficult if not impossible to measure and will constitute no meaningful risk." NUREG-0112 at B-49 and B-51.

Present Staff Evaluation:

The staff has reviewed the operating experience of TMI-1 in order to correlate calculated releases[15] with observed releases of radioactive materials in liquid and gaseous effluents. These data are presented in Tables 5-2 and 5-4 of the TMI-1 Restart SER (NUREG-0680). Since the staff does not consider data from the first year of operation to be representative of the long-term operating life of the plant, only effluent release data from January 1976 through December 1978 were used in

---

[15] The effluent calculations were made using the model and parameters described in NUREG-0017, Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-GALE Code). The data derived from these calculations can be found in the staff's TMI-1 Restart SER (NUREG-0680) in Tables 5-1 and 5-2.

comparing the actual TMI-1 releases with the calculated releases. These comparisons are presented on page C5-3 of NUREG-0680. Based on these comparisons, the staff stated "[w]e believe that the calculational model reasonably characterizes the actual releases of radioactive material from this system." These data, which were generated as part of an independent evaluation of the TMI-1 liquid and gaseous radwaste systems under Appendix I to CFR Part 50 (See pages C5-2 - C5-6 of NUREG-0680), were used to calculate cost-assessment values for the total liquid and gaseous man-rem dose to the population within a 50 mile radius of the station during normal operations of Unit 1. This value, $13,400, yields an annual man-rem dose of 13 for the 3.2 million people assumed to live within 50 miles of TMI-1 in 2010 (See page C5-4). This same population will receive 400,000 man-rem from the annual average natural background dose of 0.125 rem in the Commonwealth of Pennsylvania. These values conform well to the 15 man-rem and 223,000 man-rem for the 1,868,000 people who lived within 50 miles of Unit 1 in 1972. As above, the normal fluctuation of the natural background dose is expected to exceed the small dose increment contributed by Unit 1. Therefore, the dose from normal operation to the population within 50 miles following restart of Unit 1 would not be significant.

E. Local Fogging

The Staff found that there would be:

> "Increased local fog and occasional augmentation of natural fog at Harrisburg International Airport from operation of cooling towers."

The potential for airport fogging from cooling tower operation was calculated by the applicant to be 29 hours per year for one unit and 39 hours per year for two with the effect persisting 6 to 10 hours. The applicant also stated that about half the 39 hours would be before sunrise. NUREG-0112 at B-38.

After its own analysis, the Staff characterized the applicant's estimates as "conservative" and stated that "the most

probable effect at the Station from the cooling towers is some enhancement of natural fog some distance from the plant, particularly during the winter months when the atmosphere saturation deficit is low." NUREG-0112 at B-39.

Present Staff Evaluation:

Increased local fogging from the operation of the cooling towers has occurred. Residents in the valley west of the plant site asserted, when interviewed, that fog in this area has increased and has been more persistent. The Staff has not monitored this effect. There have been no reports of any significant effect on operations at Harrisburg International Airport from operation of the cooling towers. Although restart of TMI-1 would cause this increased local fogging to resume, this would not be a significant environmental impact and, in fact, will not differ in any respect from the fogging impact from operation of Unit I which was previously evaluated and considered in the 1972 FES since the facility would operate after restart in the same cooling mode as that previously evaluated.

F. Accidental Radiation Exposure

In the 1972 FES the Staff concluded that:

> "A very low likelihood of accidental radiation exposure to nearby residents will be created."

NUREG-0112 at B-1.

Present Staff Evaluation:

Under the Commission's Statement of Interim Policy[16] dated June 13, 1980, the Staff has been directed to discuss accident considerations in its environmental review of nuclear power plants for which a final environmental impact statement has not yet been issued. Such discussions are to include a "reasoned consideration of the environmental risks (impacts)

---

[16] 45 *Fed. Reg.* 40101 (1980).

attributable to accidents at the particular facility . . ." 45 *Fed. Reg* 40103 (1980).

The Commission also stated that:

> "This change in policy is not to be construed as any lack of confidence in conclusions regarding the environmental risks of accidents expressed in any previously issued Statements, nor, absent a showing of similar special circumstances, as a basis for opening, reopening, or expanding any previous or ongoing proceeding." *Id.*

The restart of TMI-1 does not represent a "special circumstance" of the types[17] referred to in the policy statement which would require an accident analysis as described in the Commission's Statement of Interim Policy. Consequently the Staff has not prepared such an analysis of postulated accidents for this environmental impact appraisal. Further, the Staff finds no reason to invalidate its earlier conclusion and continues to believe that the likelihood of accidental radiation exposure to nearby residents as a result of the operation of TMI-1 is very low and is unchanged from that evaluated in the 1972 FES.

Notwithstanding the foregoing analysis, the staff did provide testimony in the restart proceeding in response to UCS Contention 13 which alleged that the TMI design does not provide protection against so-called Class 9 accidents and that there is not reasonable assurance that TMI-1 can be operated without endangering the health and safety of the public. Staff members Jack Rosenthal and Paul S. Check prepared testimony, presented at the hearings on January 28, 1981, which

---

[17] These were the proposed Clinch River Breeder Reactor Plant (CRBRP), a liquid-metal-cooled fast breeder reactor very different from the more conventional light water plants, and the application by Offshore Power Systems to manufacture floating nuclear plants where the special circumstances were the potentially serious consequences associated with water (liquid) pathways leading to radiological exposures if a molten reactor core were to fall into the water body on which the plant floats. 45 *Fed. Reg.* 40102.

showed, using Class 9 accident scenarios, design basis events, credible vs. incredible events and deterministic vs probablistic reviews (including safety goals), that the design of nuclear power reactors provides protection against a range of Class 9 accidents and that protection has been provided for TMI-1 for those events with nexus to the TMI-2 event.

G. Chemical Content of Liquid Effluents

In the 1972 FES the Staff found that:

> "Small amounts of chemicals will be released in the liquid effluents and cooling tower drift from the Station; but, aside from residual chlorine which will place organisms in the near vicinity of the outfall at significant risk if not carefully controlled, expected maximum concentrations to be discharged will be sufficiently low as not to pose a hazard to aquatic or human life."

NUREG-0112 at B-2.

Present Staff Evaluation:

The use of chemicals at the station was re-examined and updated in the supplement to the FES related to the operation of Unit 2.[18] Actual Unit 1 experience with chlorine discharge was evaluated in that supplement and in greater detail in testimony presented to the TMI Unit 2 ASLB.[19] The effects of Unit I operation on Susquehanna River water quality were examined again in August 1978 in conjunction with a request that the licensee be allowed to discontinue certain Unit 1

---

[18] Supplement to the FES related to the operation of TMI, Unit 2. USNRC NUREG-0112, December 1976.

[19] NRC Staff Response to Licensing Board's Question Relating to Water Use and Chemical Discharge by R. B. Samworth. Before the USNRC Atomic Safety and Licensing Board, In the Matter Metropolitan Edison Company, *et. al.* for Three Mile Island Nuclear Station, Unit 2. Following transcript page 988.

monitoring programs.[20] These later analyses confirm the FES prediction that chemical releases are "sufficiently low as not to pose a hazard to aquatic life."

There are also chemicals present in the drift from the Unit 1 cooling tower. The actual effects of these chemicals were examined preliminarily in the Unit 2 OL-FES supplement[21] and in somewhat greater detail following the Unit 2 accident.[22] No effects of tower drift are evident, effectively confirming the FES prediction.

Thus, since operation of TMI-1, if restart is authorized, will be in the same manner as previously evaluated, restart of TMI-1 should not result in chemical impacts from cooling tower drift that will differ from that previously predicted and evaluated.

H. Operation of Intake and Discharge System

The Staff found that:

> "Operation of intake and discharge system will cause some localized destruction of minute aquatic organisms and some local alteration of fish populations."

NUREG-0112 at B-2

Present Staff Evaluation:

Several recent reviews have been performed of the effects of cooling water withdrawal at TMI on Susquehanna River aqua-

---

[20] Environmental Impact Appraisal by the Office of Nuclear Reactor Regulation Supporting Amendment No. 51 to Facility Operating License No. DPR-50. Attached to letter, dated January 28, 1980, From R. W. Reid, NRC, to R. C. Arnold, Metropolitan Edison Company.

[21] Supplement to the FES related to the operation of TMI, Unit 2 USNRC NUREG-0112, December 1976.

[22] Gears, G. E., et al., Investigations of Reported Plant and Animal Health Effects in the Three Mile Island Area. USNRC, NUREG 0738, October, 1980.

tic resources. Fish impingement and entrainment data collected at Unit 1 during 1974 and 1975 were used in the preoperational NEPA environmental review for Unit 2[23], for the Unit 2 OL hearing[24], and for assessment of Environmental Technical Specification modifications at Unit 1.[25] Annual reports of ecological monitoring and intake impacts at TMI during 1978 and 1979 for both units[26], are complete, as required by the Unit 2 Environmental Technical Specifications. Those reports also summarize results for 1976 and 1977.

The review of Unit 1 data found impacts resulting from operation to be minimal and insignificant.[27] The impacts of

---

[23] Final Supplement to the Final Environmental Statement related to operation of Three Mile Island Nuclear Station, Unit 2 (NUREG-0112) which was issued in December 1976.

[24] NRC Staff Response of C. R. Hickey, Jr. to Licensing Board's Question Relating to Aquatic Impacts. Before the USNRC Atomic Safety and Licensing Board, In the Matter of Metropolitan Edison Company, *et al.* for the Three Mile Island Nuclear Station, Unit 2., 50 p. following transcript page 988, May 2, 1977, Harrisburg, PA.

[25] U.S. Nuclear Regulatory Commission. Environmental Impact Appraisal by the Office of Nuclear Reactor Regulation, Supporting Amendment No. 51 to Facility Operating License No. DPR-50. Metropolitan Edison Company. Three Mile Island Nuclear Station, Unit No. 1. Docket No. 50-289. January 1980.

[26] Nardacci, G. A. and Associates. An Ecological Study of the Susquehanna River near the Three Mile Island Nuclear Station. Annual Report for 1978. Ichthyological Associates, Inc., Etters, PA. July 1979.

Nardacci, G. A. and Associates. An Ecological Study of the Susquehanna River near the Three Mile Island Nuclear Station. Annual Report for 1979. Ichthyological Associates, Inc., Etters, PA. April 1980.

[27] U.S. Nuclear Regulatory Commission. Environmental Impact Appraisal by the Office of Nuclear Reactor Regulation, Supporting Amendment No. 51 to Facility Operating License No. DPR-50. Metropolitan Edison Company. Three Mile Island Nuclear Station, Unit No. 1. Docket No. 50-289. January 1980.

operation of both Units 1 and 2 also were predicted to be minimal and not adverse.[28] Monitoring during years of two-unit operation (1978-1979)[29], has confirmed that impingement has had insignificant effects on river fishes. Studies conducted during 1978 (as required by the ETS) showed that the methods used to sample fish egg and larva entrainment during 1974 and 1975 were not effective[30] and that entrainment losses were underestimated. Impacts to fish populations do not appear to be occurring, however. The river supports healthy biotic populations and successful recreational fisheries. The most productive and important spawning and nursery areas of fishery species in the York Haven Pond are removed from the immediate influence of power station operation. Fishery catches and harvests appear to be related to the intensity of fishing effort and to angler behavior[31] and not to the operation of TMI.

---

[28] Final Supplement to the Final Environmental Statement related to the operation of Three Mile Island Nuclear Station, Unit 2. December 1976.

NRC Staff Response of C. R. Hickey, Jr. to Licensing Board's Question Relating to Aquatic Impacts. Before the USNRC Atomic Safety and Licensing Board, In the Matter of Metropolitan Edison Company, *et al.* for the Three Mile Island Nuclear Station, Unit 2., 50 p. following transcript page 988, May 2, 1977, Harrisburg, PA.

[29] Nardacci, G. A. and Associates. An Ecological Study of the Susquehanna River near the Three Mile Island Nuclear Station. Annual Report for 1978. Ichthyological Associates, Inc., Etters, PA. July 1979.

Nardacci, G. A. and Associates. An Ecological Study of the Susquehanna River near the Three Mile Island Nuclear Station. Annual Report for 1979. Ichthyological Associates, Inc., Etters, PA. April 1980.

[30] Nardacci, G. A. and Associates. An Ecological Study of the Susquehanna River near the Three Mile Island Nuclear Station. Annual Report for 1978. Ichthyological Associates, Inc., Etters, PA. July 1979.

[31] Hickey, C. R., Jr. and R. B. Samworth. Non-radiological consequences to the aquatic biota and fisheries of the Susquehanna River from the 1979 accident at Three Mile Island Nuclear Station.

In summary, operational monitoring has confirmed that impacts associated with cooling water withdrawal by TMI Unit 1 are minimal, as predicted in preoperational NEPA reviews. Since operation of TMI-1, if restart is authorized, will be in the same manner as that for which intake and discharge system impacts were previously predicted and evaluated, restart of TMI-1 will not result in different or increased impacts relative to those previously evaluated.

I. Visual Impact Of Cooling Towers And Transmission Lines

In the FES for TMI-1 and TMI-2, the Staff found that there would be:

> "some visual impact from the cooling towers and transmission lines."

NUREG-0112 at B-2.

Present Staff Evaluation:

No mitigation of the above impacts were required. The cooling towers and transmission lines continue to be visible and the restart of Unit 1 will not alter this circumstance in any manner.

Summary

The Staff has evaluated the environmental effects of the further operation of TMI-1 and re-examined the impacts initially presented in the 1972 FES for Units 1 and 2. This has not led to the identification of any new environmental impacts or

---

USNRC, NUREG-0596. November 1979.

Hickey, C. R., Jr. Assessment of the consequences to the recreational fishery of the Susquehanna River from the 1979 accident at Three Mile Island Nuclear Station. USNRC Draft NUREG-0754. December 1980.

any significant changes in those identified previously with respect to the proposed restart of Three Mile Island Unit 1.[32]

The staff therefore recommends, since this environmental impact appraisal does not reveal significant environmental impacts if TMI-1 restart is authorized, issuance of a negative declaration.

---

[32] Since impacts from restart will not differ in kind or degree from those previously identified and evaluated in the FES prepared for initial licensing of TMI-1, we have determined that an environmental impact statement need not be prepared for the restart of TMI-1. Accordingly, alternatives to restart need not be considered under Section 102(2)(C) (42 U.S.C. 4332(2)(C)) of the National Environmental Policy Act (NEPA). In addition, we have determined that restart of the facility will not involve unresolved conflicts concerning alternative uses of available resources that would require consideration of alternatives under Section 102(2)(E) (42 U.S.C. 4332(2)(E)) of NEPA. Consequently, alternatives to restart of TMI-1 were not considered in this appraisal.

SUPPLEMENT TO THE ENVIRONMENTAL IMPACT APPRAISAL BY THE DIVISION OF ENGINEERING EVALUATING THE PROPOSED RESTART OF THREE MILE ISLAND NUCLEAR STATION, UNIT 1

DOCKET NO. 50-289

An Environmental Impact Appraisal (EIA) relating to the proposed restart of Three Mile Island, Unit 1 was issued by the NRC Staff in March 1981. In a motion filed by Intervenor Steven C. Sholly "To Reject the NRC Staff Environmental Impact Appraisal on TMI-1 Restart or in the Alternative to Seek Leave from the Board to Raise New Contentions" (April 9, 1981) and in the Commonwealth of Pennsylvania's response to that motion (April 22, 1981), certain deficiencies in the EIA were alleged. As set forth in the NRC staff's response to the Commonwealth (May 11, 1981), certain of the alleged deficiencies were identified as requiring supplementation of the EIA. Those matters are (1) the impacts of construction of the Interim Solid Waste Staging Facility, (2) the cumulative doses to the public from restart of TMI-1 and decontamination of TMI-2, and (3) the environmental impacts of the alert-notification system for increased emergency preparedness. These subjects are addressed below.

Construction Impacts of the Interim Solid Waste Staging Facility

The Staff is still of the opinion that all construction relating to Unit 1 which would cause disturbance of land onsite and of adjacent waters is complete. The interim solid waste staging facility is, to the Staff's knowledge, the only further outside construction connected in any way with Unit 1 which is planned prior to restart of that unit. It will be built in a severely disturbed industrial area on the Island. There will be no new environmental impacts. The environmental impacts of the initial construction disturbance were clearly spelled out in the Staff's 1972 FES (See NUREG-0112, page B-34).

The building will be directly south of the electrical switchyard and between it and the northern-most Unit 2 cooling

tower. It is designed to be a buffer against shipping delays or other problems and contains separate staging areas for low level wastes from each unit. It will be, in the Staff's view, a significant improvement over the present staging facilities for low-level radioactive wastes from Unit 1 prior to shipment since a former construction storage building in the far south-east corner of the fenced-in area is now being used for this purpose.

AN ASSESSMENT OF THE RISK TO HUMAN HEALTH TO INDIVIDUALS RESIDING AROUND TMI FROM THE COMBINED EFFECTS OF RADIOACTIVE RELEASES FROM DECONTAMINATION OF UNIT 2 AND NORMAL OPERATION OF UNIT 1

CONTENTS

I. INTRODUCTION

II. DOSES

- a. Decontamination of Unit 2
- b. Operation of Unit 1
- c. Cumulative Dose

III. HEALTH EFFECTS

- a. Decontamination of Unit 2
- b. Operation of Unit 1
- c. Cumulative Health Effects

IV. CONCLUSION

V. REFERENCES

I. INTRODUCTION

This assessment evaluates the risk to human health for individuals in the general population (excluding TMI-workers) who may be exposed to radiation resulting from radioactivity that may be released during the normal decontamination of Unit 2 and from normal operation of Unit 1. Section II presents radiation doses and Section III presents potential health effects. Dose estimates presented herein are taken from other documents as described. Cumulative doses are presented in a manner for comparison to background doses. The cumulative risk estimates are compared to risks unrelated to releases from TMI and to commonly understood risks for activities that are generally considered normal.

II. DOSES TO THE PUBLIC

The dose estimates presented here are taken from other publications and are not the result of calculations made specifically for this assessment. Both maximum individual dose estimates and population (50 mile radius) dose estimates are presented.

II.a DECONTAMINATION OF UNIT 2

The potential offsite doses due to the cleanup of TMI-2 are estimated in the "Final Programmatic EIS Related to Decontamination and Disposal of Radioactive Wastes Resulting From March 28, 1978, Accident at TMI Nuclear Station, Unit 2 (FPEIS).[1] The methodology used in that report to perform dose estimates are those described in Regulatory Guide 1.109[2] with certain modifications. The modifications and site specific parameters are given in Appendix W of the FPEIS.

In the summary of the FPEIS it is stated that the total body dose to the maximum exposed individual will range from 0.8 mrem to 2.3 mrem, provided the cleanup is conducted in accordance with the staff's estimated effluent release values. In any event, proposed effluent release criteria will limit the dose to no more than 15 mrem/yr for airborne releases, and no more than 3 mrem/yr for liquid releases.

The FPEIS presents estimates of the population dose that would be expected to occur over the entire cleanup period from both gaseous and liquid releases. The population dose was estimated to range from 10 to 1000 person-rems (FPEIS, p. 10-19), depending upon the exact decontamination methods that are employed.

Table 1 lists the dose estimates for the maximum exposed individual for the entire decontamination program for atmospheric and liquid releases. Entries are listed for each type of release, representing the full range of processing alternatives. 10 CFR 50, Appendix I design objective values are also listed.

Table 1. Dose Estimates for the Maximum Exposed Individual for the Entire Decontamination Program for Each Alternative, and Comparison with 10 CFR 50 Requirements (from FPEIS, Table, 10.11)

Option [b]	Dose (mrem) [a] (Total-body/max. organ)	
	Estimated Value	Appendix I, 10 CFR 50 Value (per yr.)
Atmospheric Releases:		
1. Ship processed water offsite	0.8/1.8	-/15
2. Natural Evaporation to Atmosphere	2.1/2.0	-/15
3. Forced Evaporation to Atmosphere — SDS/EPICOR II Processing	2.3/3.4	-/15
4. Forced Evaporation to Atmosphere SDS Processing	120./480.	-/15
5. Release Water to River — SDS/EPICOR II Processing	0.8/1.8	-/15
6. Release Water to River SDS Processing	0.8/1.8	-/15
Liquid Releases:		
1. Ship processed water offsite	.0015/.0023	3/10
2. Natural Evaporation to Atmosphere [c]	.0015/.0023	3/10
3. Forced Evaporation to Atmosphere SDS/EPICOR II Processing	0.8/1.1	3/10
4. Forced Evaporation to Atmosphere SDS Processing	7.0/16.	3/10
5. Release Water to River — SDS EPICOR II Processing	1.1/1.6	3/10
6. Release Water to River SDS Processing	9.8/23.	3/10

[a] The dose estimates represent the contribution of all decontamination programs for the entire cleanup.

[b] Dose estimates are listed separately for atmospheric releases and liquid releases, rather than adding them together, because different individuals are generally considered to be involved, and because the 10 CFR 50 dose objectives are different for each.

[c] A small fraction of water vapor may precipitate as rain over the Chesapeake Bay watershed.

Table 2 lists dose estimates to the projected population in year 2010 residing within a 50 mile radius of TMI resulting from atmospheric and liquid releases from the facility. Two entries are listed and represent a bounding range of processing options.

Table 2. Population Dose Estimates for the Population Residing Within 50 Miles of the Facility for the Range of Processing and Disposal Alternatives (From FPEIS, Table 10.12)

Decontamination Option	Estimated Dose (Person rem — Total Body)
Ship Processed Water Offsite	10
Forced Evaporation of SDS Processed Water	1000

II.b OPERATION OF UNIT 1

To assure that the public will be adequately protected from radiation during normal operation of Unit 1 conditions for operation are imposed by technical specifications to the operating license. New technical specifications for Unit 1 have been submitted to NRC by Metropolitan Edison Company by letter dated October 30, 1979. They are under staff review for conformance with the requirements of 10 CFR Part 20, 10 CFR Part 50, including Appendix I and 40 CFR Part 190, and a license amendment will be required to incorporate these technical specifications. For guidance, the staff has prepared example standard technical specifications for use by all licensees in preparing technical specifications. For pressurized water reactors the standard technical specifications are described in NUREG-0472.[3] The staff has reviewed aspects of the licensee's submittal which pertain to offsite radiation dose limits and offsite radiation monitoring. Their submittal follows NUREG-0472 in these areas.

The mechanism by which the technical specifications assure that the public health and safety is protected is by imposition of

offsite dose limits that, in turn, limit the amount of radioactive material that can be released. These limits are designed to assure that doses that could occur offsite are within certain plant design objectives which are described in the regulations (10 CFR Part 50, Appendix I). For example, for noble gases the technical specifications require that the noble gas air dose offsite be no more than 5 mrem to the total body, 15 mrem to the skin, 10 mrad gamma radiation air dose and 20 mrad beta radiation air dose during any calendar year. The licensee is required to monitor the releases and to make quarterly and annual dose calculations which are based on actual releases that occurred. If these calculations indicate that one of these requirements were exceeded, the licensee is required to report to NRC within 30 days.

Other limiting requirements fall into the following areas: 1) liquid effluent release rate, 2) liquid effluent dose, 3) gaseous effluent dose rate, 4) gaseous effluent dose (non-noble gases), and 5) total dose. The specifications are as follows:

1. The concentration of radioactive material in liquid effluents releases at any time from the site shall be limited to concentrations specified in 10 CFR Part 20, Appendix B, Table II, Column 2 for radionuclides other than dissolved or entrained noble gases.
2. The dose or dose commitment to an individual from radioactive materials in liquid effluents releases from the site shall be limited to:
   a) During any calendar quarter not greater than 1.5 mrem* to the total body and 5 mrem to any organ. +
   b) During any calendar year not greater than 3 mrem to the total body and not greater than 10 mrem to any organ. +

---

* The rem is a measure of the dose of any ionizing radiation to the body tissues in terms of its estimated biological effect relative to a dose of one roentgen of X-rays.

+ The liquid effluent requirements are implemented at the point of discharge to the river, hence, the dose that could occur as a result of real water intakes downstream would be expected to be significantly smaller than those limited by this specification.

3. The dose rate due to radioactive materials in gaseous effluents from the site shall be limited to:

   a) For noble gases not greater than 500 mrem/yr to the total body and 3000 mrem/yr to the skin.

   b) For all radioiodines and for all radioactive materials in particular form and radionuclides (other than noble gases) with half lives greater than 8 days, not greater than 1500 mrem/yr to any organ.

4. The dose to an individual from radioiodines, radioactive materials in particulate form, and radionuclides (other than noble gases) with half-lives greater than 8 days in gaseous effluents released from the unit shall be limited to:

   a) During any calendar quarter not greater than 7.5 mrem to any organ.

   b) During any calendar year not greater than 15 mrem to any organ.

5. The dose or dose commitment to any real individual from uranium fuel cycle sources is limited to less than or equal to 25 mrem to the total body or any organ, and 75 mrem to the thyroid over 12 consecutive months.*

The actual maximum individual doses that may occur offsite due to TMI-1 normal operation are expected to be less than the technical specification requirement listed above. Table 3 lists the staff's estimated doses to the maximum exposed individual as a result of normal operation of Unit 1.

---

* This specification is provided to meet the dose limitations of 40 CFR 190, the so-called Environmental Protection Agency Fuel-Cycle Standard.

Table 3. Comparison of Calculated Doses From Operation With Sections II.A, II.B, And II.C of Appendix I to 10 CFR Part 50 (Dose to Maximum Individual) (From Ref. 4, Table 5-6)

Criterion	Appendix I Dose Design Objectives	Calculated Doses
Liquid Effluents		
Dose to total body from all pathways	3 mrem/yr	2.0 mrem/yr
Dose to any organ from all pathways	10 mrem/yr	2.7 mrem/yr
Noble Gas Effluents		
Gamma dose in air	10 mrad/yr	3.4 mrad/yr
Beta dose in air	20 mrad/yr	8.9 mrad/yr
Dose to total body of an individual	5 mrem/yr	2.0 mrem/yr
Dose to skin of an individual	15 mrem/yr	5.5 mrem/yr
Radioiodine and Particulates [a]		
Dose to any organ from all pathways	15 mrem/yr	6.3 mrem/yr

[a] Carbon-14 and Tritium are included in this category.

Health risk estimates for the maximum exposed individual are presented below for both the value of 6 mrem/year, representing the "best estimate," and a value of 15 mrem/yr, representing the technical specification level. This value of 15 mrem/yr is considered to be a conservative (over estimate of true value) estimate of actual doses that are likely to occur.

Population doses for the population living within 50 miles of the plant were estimated to be in the range of 11 to about 20 person rems per unit (see Reference 5, p. 5-11 and "Final Environmental Statement of TMI, Units 1 and 2, 1972," p. V-29).[6] A value of 15 person-rems/yr will be used for the health effects estimates presented below.

II.c CUMULATIVE DOSES

Table 4 lists the doses and dose ranges for the cleanup operation at Unit 2 and for normal operation of Unit 1. Also in the table the sum of the doses from both are presented.

The average yearly cumulative dose to the population living within 50 miles of TMI for both the cleanup of Unit 2 and operation of Unit 1 is estimated to be in the range of 17 to 180* person-rems for the 6 year decontamination period. A longer decontamination period would result in a lower average yearly population dose.

Table 4. Dose Estimates for the Maximum Exposed Individual for Cleanup at Unit 2 and Normal Operation of Unit 1

	Total Body Dose (mrem/yr)	
	Technical Specification Dose During Any One Year [a]	Best Estimate of Average Yearly Dose Over 6 Year Decontamination Program
Decon. of Unit 2	15.	0.2-15 [b]
Operation of Unit 1	15.	6
Total	25. [c]	6.2-21

[a] Values in this column are based on the assumption that both cleanup of Unit 2 and Operation of Unit 1 is at maximum allowable levels of 10 CFR Part 50, Appendix I. The value 15 mrem/yr is the technical specification level resulting from radioiodines and particulates ingested via atmospheric release pathways and applies as an organ dose level and not a total body dose level. Because radionuclides absorbed by the body via food ingestion generally concentrate in specific organs, it is likely that a given organ dose reaches the 15 mrem/yr level well before the total body dose reaches that

* The value 17 was based on a 15 person-rem/yr dose for operation of Unit 1 plus a 10 person rem dose from Table 2 (low option) divided by 6 years; the value 180 was based on the same dose from Unit 1 plus the high option from Table 2, i.e., 1000 person-rem divided by 6 years.

level. Hence, the assumption of 15 mrem/yr total body, is considered to represent an upper bound of the technical specification level.

[b] The value of 0.2 comes from Option 1 of Table 1 divided by 6 years; the value of 15. comes from option 4 which would be constrained by 10 CFR 50, Appendix I to a maximum annual dose of 15 mrem.

[c] 40 CFR Part 190 limits the dose commitment to any real individual from uranium fuel cycle sources to 25 mrem/yr to the total body.

Table 5 below indicates the dose for different parts of the country due to natural background radiation to which all individuals are exposed every year. The range of natural background values over the United States is 70 to 310 mrems per year. The significance of a received radiation dose can be evaluated by comparison to natural background radiation. This has its basis in the fact that the human population has evolved in the presence of natural background radiation, and that there is no strong evidence that natural background radiation is linked to human mortality. Along these lines the National Council on Radiation Protection and Measurements stated that (p. 12)[7]: "It is unwarranted to urge people to remove themselves from areas where exposure to natural sources of radiation are of this magnitude (400 mrem/yr). This degree of exposure is not regarded currently as of sufficient magnitude to require separate consideration in the determination and control of an individual's medical or occupational exposure. There is no validated deleterious effect from natural background radiation in the portion of the population receiving the higher ranges of natural radiation but it must be recognized that satisfactory epidemiological studies to determine such effects are probably impracticable."

Table 5. Estimates of Natural "Background" Radiation Levels In the United States

	Annual Dose Rate (mrem/year)			
Location	Cosmic Radiation[a]	Terrestrial Radiation[a]	Internal Radiation[b]	Total
Atlanta, Georgia	44.7	57.2	28	130
Denver, Colorado	74.9	89.7	28	193
Harrisburg, PA	42.0	45.6	28	116

Las Vegas, Nevada	49.6	19.9	28	98
New York, NY	41.0	45.6	28	115
Pennsylvania	42.6	36.2[c]	28	107
Washington, DC	41.3	35.4	28	105
United States[d]	40-160	0-120	28	70-310

[a] From [(8) Table A-1]

[b] Based upon total for soft tissue (gonads) doses from [(9) Tables 42 and 43, p. 104].

[c] From [(8) Table A-2]

[d] From [(8) Table 15, p. 34]

The comparison of the maximum individual doses that may occur as a result of cleanup of Unit 2 and operation of Unit 1 to levels of natural background radiation and to spatial variation in natural background radiation suggests that the increased radiation dose from the plant is insignificant. In a similar fashion the natural background dose can be compared to the population dose due to the plant. Approximately 2.2 million people reside within the fifty mile radius of the plant. On the basis of Table 4, the annual natural background population dose would be about 255,000 person-rem, compared to the range of 17 to 180 person-rems from TMI. These comparisons suggest that the combined effect of cleanup of Unit 2 and operation of Unit 1 on the population will be insignificant from the offsite environmental radiation dose standpoint.

III. HEALTH EFFECTS

Radiological doses to the general public from radioactive releases from TMI may result in:

a. Late somatic effects in the form of fatal and non-fatal cancer in various body organs, following age- and organ-specific latency (delay) periods within the exposed population, and

b. Fatal and non-fatal genetic disorders in future generations of the exposed population.

Estimates of these health effects, which could occur randomly in an exposed population, are normally based on estimates of

cumulative population dose expressed as person-rems (average dose X number of people receiving dose). Population health effect estimates presented here reflect the total effect incurred by the population. In order to quantify individual risks, calculations are also presented here for the maximum exposed individual. Absolute risk estimators of 135 deaths from latent cancer per 10^6 total-body person-rems in the exposed population and 258 cases of genetic disorders per 10^6 total-body person-rems in the future generations of the exposed population were derived by the National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation in the 1972 BEIR report[10] and the Reactor Safety Study (WASH-1400, October 1975).[11] The derivation assumes a linear, nonthreshold dose-effect relationship at all sublethal dose levels.* Using the above risk estimators for cancer deaths and diseases related to genetic disorders, health risks as a result of releases from TMI were calculated for the population residing around TMI and for the maximum exposed individual. The results of these calculations are described below.

III.a DECONTAMINATION OF UNIT 2

The potential health effects to the 50 mile population due to the cleanup of TMI-2 are estimated in the FPEIS. Table 6 (taken from FPEIS, Table 10.12) lists the potential number of cancer deaths or genetic abnormalities, designated as rates, for the 50 mile population of 2.2 million people around TMI as a result of decontamination activities. As these values are much less than 1 they suggest that it is very unlikely that any future cancer death will occur in the exposed population over the remaining lifetime of the population, or that any genetic abnormality will occur in the next 5 generations of the exposed population that could be associated with the cleanup operation.

---

* The latest report by the National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation, BEIR-III,[12] suggests that the cancer risks may be even smaller than those of the 1972 BEIR report by a factor of about 2 or 3.

A better appreciation of the meaning of the numeric values in Table 6 can be gleaned by comparison of the rates of Table 6 to expected cancer death rates and genetic abnormality rates from causes other than TMI releases in the same population. For example, in 1976, about 20 percent of all deaths in the United States were due to cancer.[13] If those statistics are applied to the 2.2 million people living within 50 miles of TMI, the number of people in this population expected to die of cancer is 440,000. This number can be directly compared to the numeric rates in Table 6. This comparison indicates that the incremental chance of fatal cancer to the population or to an average individual in the population due to the decontamination activities is in the range of 1 chance in 400 million to 1 chance in 4 million, depending on the decontamination option that is chosen.

Table 6. Estimates of Potential Cancer Death Rate and Potential Genetic Abnormality Rate for Exposure of the Population Around TMI Due to Releases From Decontamination for the Range of Processing and Disposal Alternatives [a]

Decontamination Option	Estimated Dose (person-rem total body)	Rate [b] (deaths or abnormalities per 2.2 million people)	
		Cancer Fatality over Remaining Lifetime	Genetic Abnormality Over Next 5 Generations
Ship processed water offsite	10	1×10^{-3}	3×10^{-3}
Forced evaporation of — SDS processed water	1000	1×10^{-1}	3×10^{-1}

[a] All estimates rounded off to one significant figure.

[b] Population death or abnormality rate estimates are expected to be slightly smaller than the values presented here because the year-2010 population estimate of 3.2 million people was used for dose estimates from atmospheric pathways.

The BEIR-I report describes the normal incidence of diseases in which there is some evidence as being associated with a genetic component abnormality as 6 in 100, or 6 percent (p. 57, Table 4, of Ref. 10). In a similar fashion as was done for cancer death rates, the genetic abnormality rate due to the decontamination and decommissioning activities at TMI can be compared to the incidence of diseases related to genetic abnormalities from causes other than TMI releases. For the 2.2 million people in the 50 mile radius around TMI the expected incidence of non-TMI related genetic abnormalities is 132,000 ($0.06 \times 2.2 \times 10^6 = 132{,}000$). Comparing this to the rates of Table 6 indicates that the incremental chance of a genetic abnormalities [*sic*] to descendants of this population or to an average exposed individual in it over the next five generations ranges from 1 chance in 40 million to 1 chance in 400 thousand, depending upon the decontamination options which are used.

Table 7 lists the increased risk of potential cancer and genetic abnormalities due to radiation released from the cleanup of Unit 2 for the maximum exposed individual. Stated in other words, an individual dose of 0.8 to 2.3 mrem would incur an estimated increased risk of dying from cancer of between 1 in 2 million and 1 in 600,000, and an increased risk of a genetic effect to descendants over the next five generations of between 1 in 300,000 and 1 in 100,000. Similarly, an individual dose of 15 mrem would incur an estimated increased risk of dying from cancer of 1 in 100,000 and an increased risk of a genetic effect to descendants over the next five generations of 1 in 10,000.

Table 7. Increases in Maximum Exposed Individual Risk Estimates Over Background Due to the TMI-2 Cleanup

		Increased Risk to Maximum Exposed Individual Over Background(%)	
	Maximum Exposed Individual Dose	Lifetime [a] Cancer	Genetic [b]
Estimated Dose (mrem)	0.8-2.3	5.4×10^{-5}-1.5×10^{-4}	3.4×10^{-5}-9.9×10^{-4}

Maximum Dose (mrem)	15	1.0×10^{-3}	6.5×10^{-3}

[a] Value determined by multiplying cancer risk estimator (135×10^{-6}/person-rem) by the dose, divided by the normal background incidence rate (.20).

[a] Value determined by multiplying genetic risk estimator (258×10^{-6}/person-rem) by the dose, divided by the normal background incidence rate (.06).

III.b OPERATION OF UNIT 1

The population dose to the population residing within 50 miles of TMI is presented above as about 15 person-rems per year. As was done in the previous section, the potential cancer and genetic health effects are estimated. Table 8 lists these estimates. The numeric values in Table 8 can be put in relation to background incidence rates for potential cancer and for genetic abnormalities. This results in an incremental chance of fatal cancer to the population or to an average individual in the population of 1 part in 200 million, and in an incremental chance of diseases related to genetic abnormalities to the population or to an average individual in the population of 1 part in 33 million.

Table 8. Estimates of Cancer Death Rate and Genetic Abnormality Rate for Exposure of the Population Around TMI Due to Releases During Operation of Unit 1

	Rate [a] (deaths or abnormalities per 2.2 million people)	
Estimated Population Dose (person-rem total body)	Cancer Fatality over Remaining Lifetime	Genetic Abnormality Over Next 5 Generations
15	2×10^{-3}	4×10^{-3}

[a] All estimates rounded off to one significant figure.

The expected maximum individual dose due to operation of Unit 1 is presented above as 6 mrem/yr with an upper limit of 15 mrem/yr. The preceding section describes the increased risk over background incidence rates for a dose of 15 mrem as 1 part in 100,000 for cancer death and 1 part in 10,000 for genetic related effects.

III.c CUMULATIVE HEALTH EFFECTS

Table 9 lists the potential health effects and health effect ranges for the cleanup operation of Unit 2 and normal operation of Unit 1 for the maximum exposed individual. Also the sum of potential health effects for both are presented in the table. The cumulative risks to the maximum exposed individual are of order 10^{-6}.

The average yearly cumulative dose to the population living within 50 miles of TMI for both cleanup of Unit 2 and operation of Unit 1 is presented above as within the range of 17 to 180 person-rem/yr during the decontamination period. The potential health effects rates for the population of 2.2 million people is 2.3×10^{-3} to 2.4×10^{-2} for cancer and 4.4×10^{-3} to 4.6×10^{-2} for genetic related diseases. The potential health effect rates for the average exposed individual is 2.2×10^{6} times smaller than these rates, or of order 10^{-9} to 10^{-8}.

Table 9. Estimates of Potential Health Effects For the Maximum Exposed Individual for Cleanup of Unit 2 and Normal Operation of Unit 1.

	Rate[a] (death or abnormality for the maximum exposed individual per year)			
	Maximum Possible Rate		Average Expected Rate	
	Cancer Death	Genetic Abnormality	Cancer Death	Genetic Abnormality
Cleanup of Unit 2	2.0×10^{-6}	3.9×10^{-6}	2.6×10^{-8} - 2.0×10^{-6}	5.1×10^{-8} - 3.9×10^{-6}
Operation of Unit 1	2.0×10^{-6}	3.9×10^{-6}	8.0×10^{-7}	1.6×10^{-6}
Total	4.0×10^{-6}	7.8×10^{-6}	8.3×10^{-7} - 2.8×10^{-6}	1.7×10^{-6} - 5.5×10^{-6}

[a] Values based on doses of Table 4 multiplied by the risk estimators described above.

As was done above, the meaning of a risk can be better understood by comparison to natural incidence rates. As [*sic*] absolute risk of order 10^{-6} of cancer death is equivalent to an increase in the chance of dying of cancer of 1 part in 200,000. An absolute risk of order 10^{-6} of genetic abnormality is equivalent to an increase in the chance of offspring with genetic abnormalities of 1 part in 60,000. Another way of evaluating the meaning of a risk of order 10^{-6} or 10^{-8} is by study of risks from other activities that are considered normal. Table 10 lists activities that result in a risk of order 10^{-6}. These comparisons suggest that the risk level of 10^{-6} for the maximum exposed individual and 10^{-8} for the average exposed individual are negligible.

Table 10. Activities with Lifetime Risks of Order 10^{-6} (Reference 14, p. 188)

Type of Activity	Equivalent Mortality Risk of 10^{-6}
Automobile travelling	50 miles
Commercial flying	250 miles
Being a man age 60	20 minutes

The activities in Table 10 are ones in which individuals have some control over. Accidents that also have a risk order of 10^{-6} per year in which an individual has no control over are deaths incurred by lightning, tornadoes, or hurricanes (see reference 11, p. 3, Executive Summary).

IV. CONCLUSION

The cumulative population doses for the population residing within 50 miles of TMI, and maximum individual doses are presented. Effects of decontamination of Unit 2 and normal operation of Unit 1 are considered. The doses for either the maximum exposed individual or for the average exposed individual are a small fraction of natural background and within the range of geographical variation of natural background.

Potential health effects are presented for the population and for the maximum individual based on the estimated doses. The magnitude of risk is compared to non-TMI related incidence rates of cancer and genetic abnormalities and to risks of activities which are considered normal.

On the basis of the comparison of doses to natural background, and natural background fluctuations, and on the basis of the comparison of risks from radiation releases from TMI to normal background risks and to risks of activities considered normal, it is concluded that the combined effects of the cleanup of Unit 2 with normal operation of Unit 1 will result in insignificant risk to the public health.

V. REFERENCES

[1] "Final Programmatic Environmental Impact Statement Related to Decontamination and Disposal of Radioactive Wastes Resulting from March 28, 1979, accident at TMI-2," NRC Report NUREG-0683, Vol. 1 & 2, U.S. Nuclear Regulatory Commission, March 1981.

[2] USNRC Regulatory Guide, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," NRC Report 1.109, October 1977, Rev. 1.

[3] U.S. Nuclear Regulatory Commission, "Radiological Effluent Technical Specifications for PWR's," July 1979, NRC Report NUREG-0472, Rev. 2.

[4] "TMI-1 Restart", NRC Report NUREG-0680, Office of Nuclear Reactor Regulation, U.S. NRC, June, 1980.

[5] USNRC, "Final Supplement to the Final Environmental Statement Related to Operation of TMI-2," December 1976, NRC Report NUREG-0112, Washington, D.C.

[6] Ibid., Appendix B.

[7] National Council on Radiation Protection and Measurement, "Basic Radiation Protection Criteria," NCRP Report No. 39, NCRP, Washington, D.C., Jan. 15, 1971.

[8] D. T. Oakley, "Natural Radiation Exposure in the United State," EPA Report ORP/SID 72-1, U.S. Environmental Protection Agency, Washington, D.C. (1972).

[9] National Council on Radiation Protection and Measurements, "Natural Background Radiation in the United States" NCRP Report No. 45, NCRP, Washington, D.C., November 15, 1975.

[10] Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR) "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," National Academy of Sciences - National Research Council, Washington, D.C., November 1972.

[11] "Reactor Safety Study" NRC Report WASH-1400, U.S. Nuclear Regulatory Commission, October 1975.

[12] Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR-III), "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," National Academy of Sciences - National Research Council, Washington, D.C., 1980.

[13] Garfinkel, L., and E. Silverberg, "Cancer Statistics, 1979," American Cancer Society Professional Education Publication, 1979.

[14] Pochin, E., "The Acceptance of Risk," British Medical Bulletin, 31, 3, 184-190 (1975).

The Environmental Impacts of the Emergency Operations Facility

Specific design and siting information on the Three Mile Island Emergency Operations Facility (EOF) is not available at this time. Criteria for the EOF are provided in NUREG-0696. *Functional Criteria for Emergency Response Facilities.* The staff believes that the environmental impacts of an EOF are minor, comparable to those of a small office building with working and conference space for at least 35 persons.

The Environmental Impacts of the Alert-Notification System

The proposed emergency preparedness alert-notification system for Three Mile Island Nuclear Generating Station is based on 83 sirens located to assure direct coverage of essentially 100 percent of the population within about 10 miles of the site. The sirens will be mounted on wooden utility posts and strategically located near schools and firehouses wherever possible. Criteria to be met or exceeded by this system are provided in NUREG-0654, *Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants,* Revision I, Appendix 3. The system will meet the acceptable dissonant sound level described in the Federal Emergency Management Agency publication CPG-1-17, "October Warning Systems Guide". The sound levels received by any member of the public will be lower than 123 dbC, the level which may cause discomfort to individuals. Siren testing guidance requires a silent test every two weeks, a growl test quarterly and when preventive maintenance is performed, and a complete cycle test at least annually and as required for formal exercises. Advanced warning of complete cycle tests through newspapers, radio and television will minimize public disruption and confusion. After reviewing the design and testing criteria to be applied to the proposed TMI system, the staff concludes that the environmental impacts of placement and testing of the proposed system will be minor.

THE REPORT OF THE PRESIDENT'S COMMISSION ON THE ACCIDENT AT THREE MILE ISLAND—THE NEED FOR CHANGE: THE LEGACY OF TMI (October 1979)

[Footnotes Omitted]

* * * * *

OVERVIEW

SEVERITY OF THE ACCIDENT

Just how serious was the accident? Based on our investigation of the health effects of the accident, we conclude that in spite of serious damage to the plant, most of the radiation was contained and the actual release will have a negligible effect on the physical health of individuals. The major health effect of the accident was found to be mental stress.

The amount of radiation received by any one individual outside the plant was very low. However, even low levels of radiation may result in the later development of cancer, genetic defects, or birth defects among children who are exposed in the womb. Since there is no direct way of measuring the danger of low-level radiation to health, the degree of danger must be estimated indirectly. Different scientists make different assumptions about how this estimate should be made and, therefore, estimates vary. Fortunately, in this case the radiation doses were so low that we conclude that the overall health effects will be minimal. There will either be no case of cancer or the number of cases will be so small that it will never be possible to detect them. The same conclusion applies to the other possible health effects. The reasons for these conclusions are as follows.

An example of a projection derived for the total number of radiation-induced cancers among the population affected by the accident at TMI was 0.7. This number is an estimate of an average, such as the one that appears in the statement: "The average American family has 2.3 children."

In the case of TMI, what it really means is that each of some 2 million individuals living within 50 miles has a miniscule additional chance of dying of cancer, and when all of these minute probabilities are added up, they total 0.7. In such a situation, a mathematical law known as a Poisson distribution (named after a famous French mathematician) applies. If the estimated average is 0.7, then the actual probabilities for cancer deaths due to the accident work out as follows: There is a roughly 50 percent chance that there will be no additional cancer deaths, a 35 percent chance that one individual will die of cancer, a 12 percent chance that two people will die of cancer, and it is practically certain that there will not be as many as five cancer deaths.

Similar probabilities can be calculated for our various estimates. All of them have in common the following: It is entirely possible that not a single extra cancer death will result. And for all our estimates, it is practically certain that the additional number of cancer deaths will be less than 10.

Since a cancer caused by nuclear radiation is no different from any other cancer, additional cancers can only be determined statistically. We know from statistics on cancer deaths that among the more than 2 million people living within 50 miles of TMI, eventually some 325,000 people will die of cancer, for reasons having nothing to do with the nuclear power plant. Again, this number is only an estimate, and the actual figure could be as much as 1,000 higher or 1,000 lower. Therefore, there is no conceivable statistical method by which fewer than 10 additional deaths would ever be detected. Therefore, the accident may result in *no* additional cancer deaths or, if there were any, they would be so few that they could not be detected.

We found that the mental stress to which those living within the vicinity of Three Mile Island were subjected was quite severe. There were several factors that contributed to this stress. Throughout the first week of the accident, there was extensive speculation on just how serious the accident might

turn out to be. At various times, senior officials of the NRC and the state government were considering the possibility of a major evacuation. There were a number of advisories recommending steps short of a full evacuation. Some significant fraction of the population in the immediate vicinity voluntarily left the region. NRC officials contributed to the raising of anxiety in the period from Friday to Sunday (March 30-April 1). On Friday, a mistaken interpretation of the release of a burst of radiation led some NRC officials to recommend immediate evacuation. And on Friday Governor Thornburgh advised pregnant women and preschool aged children within 5 miles of TMI to leave the area. On Saturday and Sunday, other NRC officials mistakenly believed that there was an imminent danger of an explosion of a hydrogen bubble within the reactor vessel, and evacuation was again a major subject of discussion.

We conclude that the most serious health effect of the accident was severe mental stress, which was short-lived. The highest levels of distress were found among those living within 5 miles of TMI and in families with preschool children.

There was very extensive damage to the plant. While the reactor itself has been brought to a "cold shutdown," there are vast amounts of radioactive material trapped within the containment and auxiliary buildings. The utility is therefore faced with the massive cleanup process that carries its own potential dangers to public health. The ongoing cleanup operation at TMI demonstrates that the plant was inadequately designed to cope with the cleanup of a damaged plant. The direct financial cost of the accident is enormous. Our best estimate puts it in a range of $1 to $2 billion, even if TMI-2 can be put back into operation. (The largest portion of this is for replacement power estimated for the next few years.) And since it may not be possible to put it back into operation, the cost could even be much larger.

The accident raised concerns all over the world and led to a lowering of public confidence in the nuclear industry and in the NRC.

From the beginning, we felt it important to determine not only how serious the actual impact of the accident was on public health, but whether we came close to a catastrophic accident in which a large number of people would have died. Issues that had to be examined were whether a chemical (hydrogen) or steam explosion could have ruptured the reactor vessel and containment building, and whether extremely hot molten fuel could have caused severe damage to the containment. The danger was never—and could *not* have been—that of a *nuclear* explosion (bomb).

We have made a conscientious effort to get an answer to this difficult question. Since the accident was due to a complex combinaton of minor equipment failures and major inappropriate human actions, we have asked the question: "What if one more thing had gone wrong?"

We explored each of several different scenarios representing a change in the sequence of events that actually took place. The greatest concern during the accident was that significant amounts of radioactive material (especially radioactive iodine) trapped within the plant might be released. Therefore, in each case, we asked whether the amount released would have been smaller or greater, and whether large amounts could have been released.

Some of these scenarios lead to a more favorable outcome than what actually happened. Several other scenarios lead to increases in the amount of radioactive iodine released, but still at levels that would not have presented a danger to public health. But we have also explored two or three scenarios whose precise consequences are much more difficult to calculate. They lead to more severe damage to the core, with additional melting of fuel in the hottest regions. These consequences are, suprisingly, independent of the age of the fuel.

Because of the uncertain physical condition of the fuel, cladding, and core, we have explored certain special and severe conditions that would, unequivocally, lead to a fuel-melting accident. In this sequence of events fuel melts, falls to the

bottom of the vessel, melts through the steel reactor vessel, and finally, some fuel reaches the floor of the containment building below the reactor vessel where there is enough water to cover the molten fuel and remove some of the decay heat. To contain such an accident, it is necessary to continue removing decay heat for a period of many months.

At this stage we approach the limits of our engineering knowledge of the interactions of molten fuel, concrete, steel, and water, and even the best available calculations have a degree of uncertainty associated with them. Our calculations show that even if a meltdown occurred, there is a high probability that the containment building and the hard rock on which the TMI-2 containment building is built would have been able to prevent the escape of a large amount of radioactivity. These results derive from very careful calculations, which hold only insofar as our assumptions are valid. We cannot be absolutely certain of these results.

Some of the limits of this investigation were: (1) We have not examined possible consequences of operator error during or after the fuel melting process which might compromise the effectiveness of containment; (2) We have not examined the vulnerability of the various electrical and plumbing penetrations through the walls or the doorways for people and equipment; (3) The analysis was specific to the TMI-2 design and location (for example, the bedrock under the plant); (4) We recognize that we have only explored a limited number of alternatives to the question "What if . . .?" and, others may come up with a plausible scenario whose results would have been even more serious.

We strongly urge that research be carried out promptly to identify and analyze the possible consequences of accidents leading to severe core damage. Such knowledge is essential for coping with results of future accidents. It may also indicate weaknesses in present designs, whose correction would be important for the prevention of serious accidents.

These uncertainties have not prevented us from reaching an overwhelming consensus on corrective measures. Our reasoning is as follows: Whether in this particular case we came close to a catastrophic accident or not, this accident was too serious. Accidents as serious as TMI should not be allowed to occur in the future.

The accident got sufficiently out of hand so that those attempting to control it were operating somewhat in the dark. While today the causes are well understood, 6 months after the accident it is still difficult to know the precise state of the core and what the conditions are inside the reactor building. Once an accident reaches this stage, one that goes beyond well-understood principles, and puts those controlling the accident into an experimental mode (this happened during the first day), the uncertainty of whether an accident could result in major releases of radioactivity is too high. Adding to this the enormous damage to the plant, the expensive and potentially dangerous cleanup process that remains, and the great cost of the accident, we must conclude that—whatever worse could have happened—the accident had already gone too far to make it tolerable.

While throughout this entire document we emphasize that fundamental changes are necessary to prevent accidents as serious as TMI, we must not assume that an accident of this or greater seriousness cannot happen again, even if the changes we recommend are made. Therefore, in addition to doing everything to prevent such accidents, we must be fully prepared to minimize the potential impact of such an accident on public health and safety, should one occur in the future.

HANDLING OF THE EMERGENCY

Another area of our investigation dealt with the questions of whether various agencies made adequate preparations for an emergency and whether their responses to the emergency were satisfactory. Our finding is negative on both questions.

We are disturbed both by the highly uneven quality of emergency plans and by the problems created by multiple jurisdictions in the case of a radiation emergency. Most emergency plans rely on prompt action at the local level to initiate a needed evacuation or to take other protective action. We found an almost total lack of detailed plans in the local communities around Three Mile Island. It is one of the many ironies of this event that the most relevant planning by local authorities took place during the accident. In an accident in which prompt defensive steps are necessary within a matter of hours, insufficient advance planning could prove extremely dangerous.

We favor the centralization of emergency planning and response in a single agency at the federal level with close coordination between it and state and local agencies. Such agencies would need expert input from many other organizations, but there should be a single agency that has the responsibility both for assuring that adequate planning takes place and for taking charge of the response to the emergency. This will require organizational changes, since the agencies now best organized to deal with emergencies tend to have most of their experience with such events as floods and storms, rather than with radiological events. And, insofar as radiological events require steps that go beyond those in a normal emergency, careful additional planning is needed.

A central concept in the current siting policy of the NRC is that reactors should be located in a "low population zone" (LPZ), an area around the plant in which appropriate protective action could be taken for the residents in the event of an accident. However, this concept is implemented in a strange, unnatural, and round-about manner. To determine the size of the LPZ, the utility calculates the amount of radiation released in a *very serious* hypothetical accident. Using geographical and meteorological data, the utility then calculates that area within which an individual would receive 25,000 millirems or more to the whole body, during the entire course of the accident. This area is the LPZ. The 25,000-millirem standard is an extremely

large dose, many times more serious than that received by any individual during the entire TMI accident.

The LPZ approach has serious shortcomings. First, because of the extremely large dose by which its size is determined, the LPZs for many nuclear power plants are relatively small areas, 2 miles in the case of TMI. Second, if an accident as serious as the one used to calculate the LPZ were actually to occur, it is evident that many people living outside the LPZ would receive smaller, but still massive doses of radiation. Third, the TMI accident shows that the LPZ has little relevance to the protection of the public—the NRC itself was considering evacuation distances as far as 20 miles, even though the accident was far less serious than those postulated during siting. We have therefore concluded that the entire concept is flawed.

We recommend that the LPZ concept be abandoned in siting and in emergency planning. A variety of possible accidents should be considered during siting, particularly "smaller" accidents which have a higher probability of occurring. For each such accident, one should calculate probable levels of radiation releases at a variety of distances to decide the kinds of protective action that are necessary and feasible. Such protective actions may range from evacuation of an area near the plant, to the distribution of potassium iodide to protect the thyroid gland from radioactive iodine, to a simple instruction to people several miles from the plant to stay indoors for a specified period of time. Only such an analysis can predict the true consequences of a radiological incident and determine whether a particular site is suitable for a nuclear power plant. Similarly, emergency plans should have built into them a variety of responses to a variety of possible kinds of accidents. State and local agencies must be prepared with the appropriate response once information is available on the nature of an accident and its likely levels of releases.

The response to the emergency was dominated by an atmosphere of almost total confusion. There was lack of communication at all levels. Many key recommendations were made by

individuals who were not in possession of accurate information, and those who managed the accident were slow to realize the significance and implications of the events that had taken place. While we have attempted to address these shortcomings in our recommendations, it is important to reiterate the fundamental philosophy we stated above: One must do everything possible to prevent accidents of this seriousness, but at the same time assume that such an accident may occur and be prepared for response to the resulting emergency. The fact that too many individuals and organizations were not aware of the dimensions of serious accidents at nuclear power plants accounts for a great deal of the lack of preparedness and the poor quality of the response.

PUBLIC AND WORKER HEALTH AND SAFETY

We have identified a number of inadequacies with respect to procedures and programs to prevent or minimize hazards to health from radiation exposure from the operations of nuclear power plants. In setting standards for permissible levels of worker exposure to radioactivity, in plant siting decisions, and in other areas related to health, the NRC is not required to, and does not regularly seek, advice or review of its health-related guidelines and regulations from other federal agencies with radiation-related responsibilities in the area of health, for example the Department of Health, Education, and Welfare (HEW) or the Environmental Protection Agency (EPA). There is inadequate knowledge of the effects of low levels of ionizing radiation, of strategies to mitigate the health hazards of exposure to radiation, and of other areas relating to regulation setting to protect worker and public health. In preparation for a possible emergency such as the accident at TMI-2, various federal agencies (NRC, Department of Energy, HEW, and EPA) have assigned responsibilities, but planning prior to the accident was so poor that ad hoc arrangements among these federal agencies had to be made to involve them and coordinate their activities.

The Commonwealth of Pennsylvania, its Bureau of Radiation Protection and Department of Health—agencies with responsibilities for public health—did not have adequate resources for dealing with radiation health programs related to the operation of TMI. The utility was not required to, and did not, keep a record on workers of the total work-related plus non-work-related (for example, medical or dental) radiation exposure.

We make recommendations with respect to improving the coordination and collaboration among federal and state agencies with radiation-related responsibilities in the health area. We believe more emphasis is required on research on the health effects of radiation to provide a sounder basis for guidelines and regulations related to worker and public health and safety. We believe that both the state and the utility have an opportunity and an obligation to establish more rigorous programs for informing workers and the public on radiation health-related issues and procedures to prevent adverse health effects of radiation.

RIGHT TO INFORMATION

The President asked us to investigate whether the public's right to information during the emergency was well served. Our conclusion is again in the negative. However, here there were many different causes, and it is both harder to assign proper responsibility and more difficult to come up with appropriate recommendations. There were serious problems with the sources of information, with how this information was conveyed to the press, and also with the way the press reported what it heard.

We do not find that there was a systematic attempt at a "cover-up" by the sources of information. Some of the official news sources were themselves confused about the facts and there were major disagreements among officials. On the first day of the accident, there was an attempt by the utility to minimize its significance, in spite of substantial evidence that it

was serious. Later that week, NRC was the source of exaggerated stories. Due to misinformation, and in one case (the hydrogen bubble) through the commission of scientific errors, official sources would make statements about radiation already released (or about the imminent likelihood of releases of major amounts of radiation) that were not justified by the facts—at least not if the facts had been correctly understood. And NRC was slow in confirming good news about the hydrogen bubble. On the other hand, the estimated extent of the damage to the core was not fully revealed to the public.

A second set of problems arose from the manner in which the facts were presented to the press. Some of those who briefed the press lacked the technical expertise to explain the events and seemed to be cut off from those who could have provided this expertise. When those who did have the knowledge spoke, their statements were often couched in "jargon" that was very difficult for the press to understand. The press was further disturbed by the fact that, in order to cut down on the amount of confusion, a number of potential sources of information were instructed not to give out information. While this cut down on the amount of confusion, it flew in the face of the long tradition of the press of checking facts with multiple sources.

Many factors contributed to making this event one of the most heavily covered media events ever. Given these circumstances, the media generally attempted to give a balanced presentation which would not contribute to an escalation of panic. There were, however, a few notable examples of irresponsible reporting and some of the visual images used in the reporting tended to be sensational.

Another severe problem was that even personnel representing the major national news media often did not have sufficient scientific and engineering background to understand thoroughly what they heard, and did not have available to them people to explain the information. This problem was most serious in the reporting of the various releases of radiation and the explanation of the severity (or lack of severity) of these

releases. Many of the stories were so garbled as to make them useless as a source of information.

We therefore conclude that, while the extent of the coverage was justified, a combination of confusion and weakness in the sources of information and lack of understanding on the part of the media resulted in the public being poorly served.

In considering the handling of information during the nuclear accident, it is vitally important to remember the fear with respect to nuclear energy that exists in many human beings. The first application of nuclear energy was to atomic bombs which destroyed two major Japanese cities. The fear of radiation has been with us ever since and is made worse by the fact that, unlike floods or tornadoes, we can neither hear nor see nor smell radiation. Therefore, utilities engaged in the operation of nuclear power plants, and news media that may cover a possible nuclear accident, must make extraordinary preparation for the accurate and sensitive handling of information.

There is a natural conflict between the public's right to know and the need of disaster managers to concentrate on their vital tasks without distractions. There is no simple resolution for this conflict. But significant advance preparation can alleviate the problem. It is our judgment that in this case, neither the utility nor the NRC nor the media were sufficiently prepared to serve the public well.

* * * * *

COMMISSION FINDINGS

B. HEALTH EFFECTS

1. Based on available dosimetric and demographic information:

a. It is estimated that between March 28 and April 15, the collective dose resulting from the radioactivity released to the population living within a 50-mile radius of the plant was approximately 2,000 person-rems. The estimated annual col-

lective dose to this population from natural background radiation is about 240,000 person-rems. Thus, the increment of radiation dose to persons living within a 50-mile radius due to the accident was somewhat less than one percent of the annual background level. The average dose to a person living within 5 miles of the nuclear plant was calculated to be about 10 percent of annual background radiation and probably was less.

b. The maximum estimated radiation dose received by any one individual in the off-site general population (excluding the plant workers) during the accident was 70 millirems. On the basis of present scientific knowledge, the radiation doses received by the general population as a result of exposure to the radioactivity released during the accident were so small that there will be no detectable additional cases of cancer, developmental abnormalities, or genetic ill-health as a consequence of the accident at TMI.

c. During the period from March 28 to June 30, three TMI workers received radiation doses of about 3 to 4 rems; these levels exceeded the NRC maximum permissible quarterly dose of 3 rems.

d. The process of recovery and cleanup presents additional sources of possible radiation exposure to the workers and the general population.

2. There were deficiencies in instrumentation for measuring the radioactivity released, particularly during the early stages of the accident. However, these deficiencies did not affect the Commission staff's ability to estimate the radiation doses or health effects resulting from the accident.

3. The health effects of radiation dose levels of a few rems or less are not known. Estimates of the potential health effects of the TMI accident are based on extrapolations from the known health effects of higher levels of radiation.

4. The major health effect of the accident appears to have been on the mental health of the people living in the region of Three Mile Island and of the workers at TMI. There was

immediate, short-lived mental distress produced by the accident among certain groups of the general population living within 20 miles of TMI. The highest levels of distress were found among adults a) living within 5 miles of TMI, or b) with preschool children; and among teenagers a) living within 5 miles of TMI, b) with preschool siblings, or c) whose families left the area. Workers at TMI experienced more distress than workers at another plant studied for comparison purposes. This distress was higher among the nonsupervisory employees and continued in the months following the accident.

* * * * *

ACCOUNT OF THE ACCIDENT

At NRC headquarters, Lake Barrett, a section leader in the environmental evaluation branch, was concerned about the waste gas decay tank level. The previous evening, he had helped calculate "a hypothetical release rate" for the radiation that would escape if the tank's relief valves opened. Shortly before 9:00 a.m., Barrett was told of a report from Three Mile Island that the waste gas decay tanks had filled. He was asked to brief senior NRC staff officials on the significance of this. The group included Lee Gossick, executive director for operations; John Davis, then acting director of Inspection and Enforcement; Harold Denton, director of Nuclear Reactor Regulation; Victor Stello, Jr., then director of the Office of Operating Reactors; and Harold Collins, assistant director for emergency preparedness in the Office of State Programs. During the briefing, Barrett was asked what the release rate would mean in terms of an off-site dose. He did a quick calculation and came up with a figure: 1,200 millirems per hour at ground level. Almost at that moment, someone in the room reported a reading of 1,200 millirems per hour had been detected at Three Mile Island. By coincidence, the reading from TMI was identical to the number calculated by Barrett. "It was the exact same number, and it was within maybe 10 or 15 seconds from my first 1,200 millirems per hour prediction," Barrett told the Commission.

The result was instant concern among the NRC officials; "an atmosphere of significant apprehension," as Collins described it in his testimony. Communications between the NRC headquarters and Three Mile Island had been less than satisfactory from the beginning. "I think there was uncertainty in the operations center as to precisely what was going on at the facility and the question was being raised in the minds of many as to whether or not those people up there would do the right thing at the right time, if it had to be done," Collins testified. NRC officials proceeded without confirming the reading and without knowing whether the 1,200 millirem per hour reading was on- or off-site, whether it was taken at ground level or from a helicopter, or what its source was. They would later learn that the radiation released did not come from the waste gas decay tanks. The report that these tanks had filled was in error.

After some discussion, Harold Denton directed Collins to notify Pennsylvania authorities that senior NRC officials recommended the Governor order an evacuation. Collins telephoned Oran Henderson, director of the Pennsylvania Emergency Management Agency, and, apparently selecting the distance on his own, recommended an evacuation of people as far as 10 miles downwind from Three Mile Island. Henderson telephoned Lieutenant Governor Scranton, who promised to call the Governor. A Henderson aide also notified Thomas Gerusky, director of the Bureau of Radiation Protection, of the evacuation recommendation. Gerusky knew of the 1,200 millirem reading. A telephone call to an NRC official at the plant reinforced Gerusky's belief that an evacuation was unnecessary. He tried to telephone Governor Thornburgh, found the lines busy, and went to the Governor's office to argue personally against an evacuation.

* * * * *

SATURDAY, MARCH 31

The great concern about a potential hydrogen explosion inside the TMI-2 reactor came with the weekend. That it was a

groundless fear, an unfortunate error, never penetrated the public consciousness afterward, partly because the NRC made no effort to inform the public it had erred.

Around 9:30 p.m. Friday night, the NRC chairman asked Roger Mattson to explore the rate at which oxygen was being generated inside the TMI-2 reactor system and the risk of a hydrogen explosion. "He said he had done calculations," Mattson said in his deposition. "He was concerned with the answers." Mattson is director of the Division of Systems Safety within the Office of Nuclear Reactor Regulation (NRR), which is headed by Denton, and had spent part of Thursday and Friday working on how to remove a gas bubble from the reactor. Following Denton's departure for TMI, Mattson served variously as NRR's representative or deputy representative at the Incident Response Center.

Hydrogen had been produced in the reactor as a result of a high-temperature reaction that occurred between hot steam and the zirconium cladding of the fuel rods. For this hydrogen to explode or burn—a less dangerous possibility—enough oxygen would have to enter the system to form an explosive mixture. There were fears this would happen as the result of radiolysis. In this process, radiation breaks apart water molecules, which contain hydrogen and oxygen.

Two NRC teams worked throughout the weekend on the problem, and both sought help from laboratories and scientists outside the NRC. One group addressed the rate at which radiolysis would generate oxygen at TMI-2. The second analyzed the potential for hydrogen combustion. Robert Budnitz of the NRC also asked experts about possible chemicals that might remove the hydrogen.

At noon, Hendrie talked by telephone with Denton and expressed his concern that oxygen freed by radiolysis was building up in the reactor. Earlier, Hendrie had told Victor Stello, Jr., Denton's second-in-command at TMI, the same thing. The NRC chairman told Denton that Governor Thorn-

burgh should be made aware of the potential danger. Denton promised to speak with Thornburgh.

[Photographs Omitted]

Shortly after 1:00 p.m., Mattson got some preliminary answers regarding the potential for a hydrogen explosion. An hour later, Mattson got more replies. "I had an estimate there was oxygen being generated, from four independent sources, all with known credentials in this field," he said in his deposition. "The estimate of how much oxygen varied, but all estimates said there was considerable time, a matter of several days, before there was a potential combustible mixture in the reactor coolant system."

At a Commission hearing, Mattson later admitted in response to questions from Commissioner Pigford that the NRC could have determined from the information available at the time that no excess oxygen was being generated and there was no real danger of explosion. But when Mattson met with the NRC commissioners at 3:27 p.m. on Saturday, "the bottom line of that conversation . . . was there were several days required to reach the flammability limit, although there was oxygen being generated," Mattson recalled in his deposition. "And I expressed confidence that we were not underestimating the reactor coolant system explosion potential; that is, the estimate of 2 to 3 days before reaching the flammability limit was a conservative estimate." By Saturday night, however, Mattson would be told by his consultants that their calculations indicated that the oxygen percentage of the bubble was on the threshold of the flammability limit.

Around 6:45 p.m., Mattson talked with Vincent Noonan, the man within NRC most knowledgeable about what might result from an explosion inside a reactor. One NRC consultant had predicted that a hydrogen blast would produce pressures of 20,000 pounds per square inch within the TMI-2 reactor. B&W, designer of the reactor, however, had considered the dampening effects of water vapor on an explosion and those of an enriched hydrogen environment and calculated a total pres-

sure of 3,000 to 4,000 psi. That was encouraging. Previous analyses indicated the reactor coolant system of a TMI-2 reactor could withstand blast pressures of that magnitude.

Late Saturday evening, James Taylor of B&W reiterated another B&W engineer's conclusion first relayed to the NRC Thursday night—that no excess oxygen was being generated. That information, Mattson stated in his deposition, never reached him.

Saturday at 2:45 p.m., Hendrie met with reporters in Bethesda. He said then that a precautionary evacuation out to 10 or 20 miles from the Island might be necessary if engineers attempted to force the bubble out of the reactor. NRC had concluded such an attempt might cause further damage to the core, Hendrie said, and it might touch off an explosion of the bubble.

Stan Benjamin, a reporter with the Washington bureau of the Associated Press, followed up Hendrie's press conference by interviewing two NRC officials: Edson Case, Denton's deputy in the Office of Nuclear Reactor Regulation, and Frank Ingram, a public information spokesman. From them, and an NRC source he refused to name, Benjamin learned of the concern within the Incident Response Center that the bubble could become a potentially explosive mixture within a matter of days, perhaps as few as two. Benjamin checked his story with Case and Ingram, reading much of it to them word by word, before releasing the article. Case and Ingram agreed it was accurate. The report—first transmitted as an editor's note at 8:23 p.m.—was the first notice to the public that some NRC officials feared the bubble might possibly explode spontaneously.

Denton had been briefed throughout Saturday afternoon and evening by Hendrie and NRC officials in Bethesda on the oxygen estimates and the potential for a burn or explosion. But he learned of the AP story only a short time before he joined Governor Thornburgh and Lieutenant Governor Scranton for a late evening press conference in Harrisburg. The Governor

assured reporters that "there is no imminent catastrophic event foreseeable at the Three Mile Island facility." Denton, too, said: "There is not a combustible mixture in the containment or in the reactor vessel. And there is no near-term danger at all." Denton also tried to deflate the impression, voiced by several reporters, that contradictions existed between himself and his colleagues at NRC headquarters. "No, there is no disagreement. I guess it is the way things get presented," he said.

But there was disagreement, and Denton wanted it resolved. President Carter had announced earlier in the evening he would visit TMI the following day. Denton told Stello to explore the oxygen-hydrogen issue further with outside experts. Stello realized the concern in Washington. He had received a telephone call shortly after 9:00 p.m. from Eugene Eidenberg, a Presidential aide, inquiring about the AP story. Stello told the White House that he did not share the concern felt at NRC headquarters.